Appendix 6
Surface Water Resources

Line items and numbers identified or noted as "No Action Alternative" represent the "Existing Conditions/No Project/No Action Condition" (described in Chapter 2 Alternatives Analysis). Table numbering may not be consecutive for all appendixes.

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Appendix 6A
Modeling of Alternatives

Line items and numbers identified or noted as “No Action Alternative” represent the “Existing Conditions/No Project/No Action Condition” (described in Chapter 2 Alternatives Analysis). Table numbering may not be consecutive for all appendixes.

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Appendix 6A
Modeling of Alternatives

CALSIM II and DSM2 Modeling Assumptions for Sites Reservoir Alternatives

6A.1 Introduction

This appendix describes the assumptions for the CALSIM II and DSM2 modeling of the Existing Conditions, No Action Alternative, and Sites Reservoir Project (Project) alternatives included in the Sites Reservoir Project Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS).

The following model simulation was prepared as the basis of evaluating the impacts of the Project alternatives:

1. Existing Conditions/No Project/No Action Condition

The following model simulations of alternatives were prepared:

1. Alternative A – includes a 1.3-million-acre-foot (MAF) Sites Reservoir with conveyance to and from the reservoir provided by the existing Tehama-Colusa and Glenn-Colusa Irrigation District (GCID) Main canals and a new Delevan Pipeline (2,000-cubic-foot-per-second [cfs] diversion/1,500-cfs release)
2. Alternative B – includes a 1.8-MAF Sites Reservoir with conveyance to and from the reservoir provided by the existing Tehama-Colusa and GCID Main canals, and a new release–only Delevan Pipeline (1,500-cfs release)
3. Alternative C – includes a 1.8-MAF Sites Reservoir with conveyance to and from the reservoir provided by the existing Tehama-Colusa and GCID Main canals and a new Delevan Pipeline (2,000-cfs diversion/1,500-cfs release)
4. Alternative D – includes a 1.8-MAF Sites Reservoir with conveyance to and from the reservoir provided by the existing Tehama-Colusa and GCID Main canals and a new Delevan Pipeline (2,000-cfs diversion/1,500-cfs release); 480 thousand acre-feet (TAF) of Sites storage is reserved for local project participants in the Colusa Basin

Existing Conditions/No Project/No Action Condition modeling assumptions were developed through a coordinated process with the Federal and State Lead Agencies to reflect the best CALSIM II and DSM2 model representation of the Reasonable and Prudent Actions (RPAs) in the 2008 Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) Biological Opinions (BOs).

Alternatives A, B, and C modeling assumptions were developed by the North-of-Delta Offstream Storage (NODOS) EIR/EIS Lead Agencies, Alternative D modeling assumptions were developed by the Sites Project Authority (Authority).

6A.2 Assumptions for Existing Conditions/No Project/ No Action Condition Model Simulations

As described in Chapter 2 Alternatives Analysis, because facilities, regulatory regime, and water demands would be similar under the Existing Conditions and the No Project/No Action Alternative under year 2017 conditions, the analysis in this EIR/EIS assumes that the Existing Conditions baseline and No Project/No Action Alternative are similar and substantially the same baseline condition. Therefore, the identification of impacts for this Draft EIR/EIS is based on the evaluation of the action alternatives compared to what is termed the "Existing Conditions/No Project/No Action Condition."

This section presents the assumptions used in developing the CALSIM II and DSM2 model simulations for the Existing Conditions/No Project/No Action Condition used in the Sites Reservoir Draft EIR/EIS evaluation. The No Action Alternative CALSIM II and DSM2 models developed for the NODOS Feasibility Study and EIR/EIS were used for the Sites Reservoir Draft EIR/EIS Existing Conditions/No Project/No Action Condition. The modeling assumptions were selected by the California Department of Water Resources (DWR) and Bureau of Reclamation (Reclamation) management team for the NODOS Feasibility Study and EIR/EIS.

The assumptions were selected to satisfy California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) requirements. The basis for these assumptions is described in the Chapter 2 Alternative Analysis. Assumptions that are applicable to the CALSIM II and DSM2 modeling are included in the following section.

The Existing Conditions/No Project/No Action Condition assumptions include implementation of water operations components of the RPAs specified in the 2008 USFWS and 2009 NMFS BOs. The specific assumptions and implementation in the CALSIM II and DSM2 models were developed by a multiagency team comprised of fisheries and modeling experts from the DWR, California Department of Fish and Game (CDFG, now known as California Department of Fish and Wildlife [CDFW]), Reclamation, USFWS, and NMFS.

In Section 6A.2.1 Existing Conditions/No Project/No Action Condition, the description of CALSIM II and DSM2 assumptions refer to the No Action Alternative. However, these assumptions are applicable to the Existing Conditions/No Project/No Action Condition in the Sites Reservoir Draft EIR/EIS. The detailed assumptions used in developing CALSIM II and DSM2 simulations for the Existing Conditions/No Project/No Action Condition are included in Section 6A.4 Existing Conditions/No Project/No Action Condition Modeling Assumptions Callout Tables, in Tables 6A-5 and 6A-6. Additional information is provided in the footnotes of each table. Table entries and footnotes refer to supporting appendix sections and other documents. Even though these tables show different assumptions for the Existing Conditions and the No Action Alternative, as previously noted, the No Action Alternative was used to represent the Existing Conditions/No Project/No Action Condition in the Draft EIR/EIS.

The Existing Conditions/No Project/No Action Condition simulation was developed assuming Year 2030 level of development and regulatory conditions. The Existing Conditions/No Project/No Action Condition assumptions include existing facilities and ongoing programs that existed as of March 2017 (publication of the Notice of Preparation) that could affect or could be affected by implementation of the alternatives. The Existing Conditions/No Project/No Action Condition assumptions and the models do not include any restoration actions or additional conveyance over the current conditions.

6A.2.1 CALSIM II Assumptions for Existing Conditions/No Project/No Action Condition

6A.2.1.1 Hydrology

Inflows/Supplies

CALSIM II model includes the historical hydrology with projected 2030 modifications for the operations upstream of the rim reservoirs. Reservoir inflows, stream gains, diversion requirements, irrigation efficiencies, return flows and groundwater operation are all components of the hydrology for CALSIM II.

Level of Development

CALSIM II input hydrology is based on an analysis of agricultural and urban land use and population estimates. The assumptions used for Sacramento Valley land use result from aggregation of historical survey and projected data developed for the California Water Plan Update (Bulletin 160-98). Generally, land use projections are based on Year 2020 estimates (hydrology serial number 2020D09E). However, the San Joaquin Valley hydrology reflects draft 2030 land use assumptions developed by Reclamation. Where appropriate Year 2030 projections of demands associated with water rights and State Water Project (SWP) and Central Valley Project (CVP) water service contracts have been included. Specifically, projections of full build out are used to describe the American River region demands for water rights and CVP contract supplies and California Aqueduct and the Delta Mendota Canal SWP/CVP contractor demands are set to full contract amounts.

Demands, Water Rights, CVP/SWP Contracts

CALSIM II demand inputs are preprocessed monthly time series for a specified level of development (e.g. 2020) and per hydrologic conditions. Demands are classified as CVP project, SWP project, local project or non-project (e.g. pre-1914 water rights, in-Delta consumptive use etc.). CVP and SWP demands are separated into different classes based on the contract type. A description of various demands and classifications included in CALSIM II is provided in the 2008 Operations Criteria and Plan (OCAP) Biological Assessment Appendix D (Reclamation, 2008a). Non-project demands within each Depletion Study Area are based on the proportion of the acreage served by the projects versus the total acreage, for each land-use type. Non-project demands are satisfied from sources other than project storage and project conveyance facilities and are reduced as a function of water availability in the absence of project operations.

Table 6A-1 includes the summary of the CVP and SWP project demands in TAF under the No Action Alternative. The CVP municipal and industrial (M&I) demands, North-of-the-Delta, increased under No Action Alternative. The increase is mainly on the American River. More detail regarding the American River demands assumed under the No Action Alternative are provided in Section 6A.5 American River Demands. For SWP contractors, full Table A demands are assumed every year. There are small changes in the total non-project demands, as well.

The full detailed listing of SWP and CVP contract amounts and other water rights assumptions for the No Action Alternative are included in the delivery specification tables in Section 6A.7 Delivery Specifications. Table 6A-1 shows the totals of contracts assumed and the actual demands may vary and be less than the contract amounts.

Table 6A-1
Summary of SWP and CVP Demands under No Action Alternative

Project Contractor Type	North-of-the-Delta (TAF)	South-of-the-Delta (TAF)
CVP Contractors		
Settlement/Exchange	2,194	840
Water Service Contracts		
Agriculture	378	1,937
M&I	557	164
Refuges	189	281
SWP Contractors		
Feather River Service Area	796	0
Table A	114	4,056
Agriculture	0	1,032
M&I	114	3,024

Note: Urban demands are for full buildout conditions.

The No Action Alternative assumes demands north of the Delta at the future level of development assuming full build-out of facilities and increases associated with water rights and CVP and SWP service contracts. This is primarily an increase in CVP M&I service contracts (253 TAF/year) and water rights (184 TAF/year) related to urban M&I use, especially in the communities in El Dorado, Placer, and Sacramento counties. The No Action Alternative also assumes full contract amounts for demands associated with SWP contracts, south of the Delta at the future level of development, in all hydrologic conditions.

Assumed total supply that the refuges south of Delta receive under the No Action Alternative to increase in supplies for Wildlife Refuges, including Firm Level 2 supplies of about 8 TAF/year, and Level 4 supplies of about 50 TAF/year at the future level of development. Firm Level 2 supplies are met by CVP contract supply and Level 4 supplies are met through local water acquisitions. Section 6A.6 Refuge Supplies includes more details regarding the Wildlife Refuge demand assumptions.

Demands assumed in the Sites Reservoir primary study area are primarily a function of CVP agricultural service contracts for the Tehama-Colusa Canal Authority (TCCA) member agencies and CVP settlement contractors such as GCID and Reclamation District 108. Maximum water demand assumed for the CVP contractors part of the TCCA in the No Action Alternative includes 318.7 TAF/year, based on their contracts. Similarly, maximum demands assumed for GCID is 825 TAF, and Reclamation District 108 is 232 TAF/year based on their CVP settlement contracts. Actual water delivered would be lower of the land use based demand and the allocated supply based on the CVP contracts.

Facilities

CALSIM II includes representation of all the existing CVP and SWP storage and conveyance facilities. Assumptions regarding selected key facilities are included in Section 6A.4 Existing Conditions/No Project/No Action Condition Modeling Assumptions Callout Tables. Key storage facilities including Shasta Lake, Trinity Lake, Whiskeytown Lake, Lake Oroville, Folsom Lake, Los Vaqueros Reservoir, San Luis Reservoir and Millerton Lake are represented in CALSIM II. Regulating reservoirs such as Lewiston, Keswick, Thermalito, and Nimbus are also included in CALSIM II.

CALSIM II also represents existing conveyance facilities in the Colusa Basin region. Red Bluff Pumping Plant, Tehama-Colusa Canal and its intake on the Sacramento River, Corning Canal, GCID Main Canal and its intake on the Sacramento River, Stony Creek and Tehama-Colusa Canal intertie, Tehama-Colusa Canal and GCID Main Canal intertie, and Colusa Basin Drain are some of the key facilities included in the model.

CALSIM II also represents the flood control weirs along the Sacramento River such as Ord Ferry, Moulton Weir, Colusa Weir and Tisdale Weir, which bypass flood flows into Sutter Bypass. USRDOM was used to model the weir spills into the Sutter Bypass for Draft EIR/EIS alternatives. In addition, CALSIM II also represents the flood control weirs such as Fremont Weir and Sacramento Weir, which spill flood flows from the Sacramento River into Yolo Bypass.

Freeport Regional Water Project, located along the Sacramento River near Freeport, is assumed to be operational under the No Action Alternative. Similarly, 30-million-gallon-per-day capacity, City of Stockton Delta Water Supply Project is assumed to be operational under the No Action Alternative. Delta-Mendota Canal–California Aqueduct intertie is assumed to be operational under the No Action Alternative. Contra Costa Water District Alternative Intake Project and Los Vaqueros expanded storage capacity of 160 TAF, are included in the No Action Alternative along with the South Bay Aqueduct rehabilitation, to 430-cfs capacity, from junction with California Aqueduct to Alameda County Flood Control and Water Conservation District Zone 7.

Red Bluff Pumping Plant

The permanent Tehama-Colusa Canal Pumping Plant and intake facilities are in place and the Red Bluff Pumping Plant is operated with gates out of the water all year as required in the NMFS BO Action I.3.1 (Section 6A.9 NMFS RPA Implementation) providing unimpeded upstream and downstream fish passage.

Tehama-Colusa Canal Capacity

Fish Passage Improvements at Red Bluff Pumping Plant and Fish Screen are included in the No Action Alternative, allowing for a pumping capacity of 2,000 cfs into Tehama-Colusa Canal.

Glenn Colusa Canal Capacity

Three thousand cfs of total diversion capacity is assumed at the Sacramento River intake near Hamilton City into GCID Main Canal.

Existing Tehama-Colusa Canal- and GCID Main Canal Intertie

The existing Tehama-Colusa Canal-and GCID Main Canal intertie provides flexibility in routing flows of up to 285 cfs, between the Tehama-Colusa and GCID Main canals.

Williams Outlet

The Williams Outlet provides flexibility in routing flows of up to 65 cfs, between the Tehama-Colusa and GCID Main canals.

Funks Reservoir

The existing Funks Reservoir includes a storage capacity of 2,250 acre-feet and is part of the Tehama-Colusa Canal system. Funks Reservoir serves as a re-regulating reservoir to stabilize flows in the Tehama-Colusa Canal downstream of Funks Reservoir as diverters come on line and off line. Funks Reservoir is not modeled explicitly in CALSIM II.

The Delta serves as a natural system of channels to transport river flows and reservoir storage to the CVP and SWP facilities in the south Delta, which export water to the projects' contractors through two pumping plants: SWP's Harvey O. Banks Pumping Plant and CVP's C.W. Jones Pumping Plant. Banks and Jones Pumping Plants supply water to agricultural and urban users throughout parts of the San Joaquin Valley, South Lahonton, Southern California, Central Coast, and South San Francisco Bay Area regions.

The Contra Costa Canal and the North Bay Aqueduct supply water to users in the northeastern San Francisco Bay and Napa Valley areas.

SWP Banks Pumping Plant Capacity

SWP Banks pumping plant has an installed capacity of about 10,668 cfs (two units of 375 cfs, five units of 1,130 cfs, and four units of 1,067 cfs). The SWP water rights for diversions specify a maximum of 10,350 cfs, but the U.S. Army Corps of Engineers) permit for SWP Banks Pumping Plant allows a maximum pumping of 6,680 cfs. With additional diversions depending on Vernalis flows the total diversion can go up to 8,500 cfs during December 15 – March 15. Additional capacity of 500 cfs (pumping limit up to 7,180 cfs) can reduce the impact of NMFS BO Action 4.2.1 on SWP.

CVP C.W. Bill Jones Pumping Plant (Tracy Pumping Plant) Capacity

The Jones Pumping Plant consists of six pumps including one rated at 800 cfs, two at 850 cfs, and three at 950 cfs. Delta Mendota Canal-California Aqueduct Intertie that allows 400 cfs additional Delta Mendota Canal capacity is assumed to be in place; therefore, pumping capacity is 4,600 cfs in all months.

CCWD Intakes

The Contra Costa Canal originates at Rock Slough, about 4 miles southeast of Oakley, and terminates after 47.7 miles at Martinez Reservoir. The canal and associated facilities are part of the CVP, but are operated and maintained by the Contra Costa Water District (CCWD). CCWD also operates a diversion on Old River. CCWD can divert water to the Los Vaqueros Reservoir to store good quality water when available and supply to its customers. In addition to the Rock Slough and Old River diversions, CCWD's Middle River Intake and Pump Station (previously known as the Alternative Intake Project) is included in the No Action Alternative. The Alternative Intake Project is a new drinking water intake at Victoria Canal, about 2.5 miles east of CCWD's existing intake on the Old River.

6A.2.1.2 Regulatory Standards

Major regulatory standards that govern the operations of the CVP and SWP facilities are briefly described below. Specific assumptions related to key regulatory standards are also outlined below.

D-1641 Operations

The State Water Resources Control Board (SWRCB) Water Quality Control Plan (WQCP) and other applicable water rights decisions, as well as other agreements are important factors in determining the operations of both the CVP and the SWP.

The December 1994 Accord committed the CVP and SWP to a set of Delta habitat protective objectives that were incorporated into the 1995 WQCP and later, were implemented by D-1641. Significant elements in the D-1641 standards include X2 standards, export/inflow (E/I) ratios, Delta water quality standards, real-time Delta Cross Channel (DCC) operation, and San Joaquin flow standards.

Coordinated Operations Agreement

The CVP and SWP use a common water supply in the Central Valley of California. The DWR and Reclamation have built water conservation and water delivery facilities in the Central Valley to deliver water supplies to project contractors. The water rights of the projects are conditioned by the SWRCB to protect the beneficial uses of water within each respective project and jointly for the protection of beneficial uses in the Sacramento Valley and the Sacramento-San Joaquin Delta Estuary. The agencies coordinate and operate the CVP and SWP to meet the joint water right requirements in the Delta.

The Coordinated Operations Agreement (COA), signed in 1986, defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta standards, as the standards existed in SWRCB Decision 1485 (D-1485), and other legal uses of water, identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the Projects, and provides for periodic review of the agreement.

Central Valley Project Improvement Act (b)(2) Assumptions

The previous 2008 OCAP BA modeling included a dynamic representation of Central Valley Project Improvement Act (CVPIA) 3406(b)(2) water allocation, management and related actions (B2). The selection of discretionary actions for use of B2 water in each year was based on a May 2003 Department of the Interior policy decision. The use of B2 water is assumed to continue in conjunction with the USFWS and NMFS BO RPA actions. The CALSIM II implementation used for modeling for this EIR/EIS does not explicitly account for the use of (b)(2) water, but rather assumes pre-determined USFWS BO upstream fish objectives for Clear Creek and Sacramento River below Keswick Dam in addition to USFWS and NMFS BO RPA actions for the American River, Stanislaus River, and Delta export restrictions.

Continued CALFED Agreements

The Environmental Water Account (EWA) was established in 2000 by the CALFED Record of Decision (ROD). The EWA was initially identified as a 4-year cooperative effort intended to operate from 2001 through 2004 but was extended through 2007 by agreement between the EWA agencies. It is uncertain, however, whether the EWA will be in place in the future and what actions and assets it may include. Because of this uncertainty, the EWA has not been included in the current CALSIM II implementation.

One element of the EWA available assets is the Lower Yuba River Accord Component 1 water. In the absence of the EWA and implementation in CALSIM II, the Lower Yuba River Accord Component 1 water is assumed to be transferred to South of Delta SWP contractors to help mitigate the impact of the NMFS BO on SWP exports during April and May. An additional 500 cfs of capacity is permitted at Banks Pumping Plant from July through September to export this transferred water.

USFWS Delta Smelt BO Actions

The USFWS Delta Smelt BO was released on December 15, 2008, in response to Reclamation's request for formal consultation with the USFWS on the coordinated operations of the CVP and SWP in California. To develop CALSIM II modeling assumptions for the RPA documented in this BO, DWR led a series of meetings that involved members of fisheries and project agencies. This group has prepared the assumptions and CALSIM II implementations to represent the RPA in Existing Conditions CALSIM II simulation. The following actions of the USFWS BO RPA have been included in the Existing Conditions CALSIM II simulations:

- Action 1: Adult delta smelt migration and entrainment (RPA Component 1, Action 1 – First Flush)
- Action 2: Adult delta smelt migration and entrainment (RPA Component 1, Action 2)
- Action 3: Entrainment protection of larval and juvenile delta smelt (RPA Component 2)
- Action 4: Estuarine habitat during Fall (RPA Component 3)
- Action 5: Temporary spring head of Old River barrier and the Temporary Barrier Project (RPA Component 2)

A detailed description of the assumptions that have been used to model each action is included in the technical memorandum "Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies," prepared by an interagency working group under the direction of the lead agencies. This technical memorandum is included in the Section 6A.8 USFWS RPA Implementation.

NMFS BO Salmon Actions

The NMFS Salmon BO on long-term actions of the CVP and SWP was released on June 4, 2009. To develop CALSIM II modeling assumptions for the RPA documented in this BO, the DWR led a series of meetings that involved members of fisheries and project agencies. This group has prepared the assumptions and CALSIM II implementations to represent the RPA in Existing Conditions CALSIM II simulations for future planning studies. The following NMFS BO RPA have been included in the Existing Conditions CALSIM II simulations:

- Action I.1.1: Clear Creek spring attraction flows
- Action I.3.1: Operations after May 14, 2012: Operate Red Bluff Pumping Plant with gates out
- Action I.4: Wilkins Slough operations
- Action II.1: Lower American River flow management
- Action III.1.3: Stanislaus River flows below Goodwin Dam
- Action IV.1.2: Delta Cross Channel gate operations
- Action IV.2.1: San Joaquin River flow requirements at Vernalis and Delta export restrictions
- Action IV.2.3: Old and Middle River flow management

For Action I.2.1, which calls for a percentage of years that meet certain specified end-of-September and end-of-April storage and temperature criteria resulting from the operation of Lake Shasta, no specific CALSIM II modeling code is implemented to simulate the performance measures identified.

A detailed description of the assumptions that have been used to model each action is included in the technical memorandum "Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies," prepared by an interagency working group under the direction of the lead agencies. This technical memorandum is included in the Section 6A.9 NMFS RPA Implementation.

Water Transfers

Lower Yuba River Accord

Acquisitions of Component 1 water under the Lower Yuba River Accord, and use of 500-cfs dedicated capacity at Banks Pumping Plant during July – September, are assumed to be used to reduce as much of the impact of the April – May Delta export actions on SWP contractors as possible.

Phase 8 Transfers

Phase 8 transfers are not included.

Short-term or Temporary Water Transfers

Short-term or temporary transfers such as Sacramento Valley acquisitions conveyed through Banks Pumping Plant are not included.

6A.2.1.3 Specific Regulatory Assumptions

Upstream Reservoir Operations

Minimum Flow below Lewiston Dam

The volume of the Trinity River instream flow requirement below Lewiston Dam ranges from 369 to 815 TAF/year, based on the Trinity EIS Preferred Alternative. The minimum flow volume is determined based on the Trinity River water year classification. The flow schedules from the Trinity EIS Preferred Alternative were assumed for each water year type.

Trinity Lake End-of-September Minimum Storage

Based on the Trinity EIS Preferred Alternative, a minimum end-of-September carryover storage objective of 600 TAF at Trinity Reservoir was assumed to help provide cold-water resource protection. This objective may not be fully accomplished in extended drought periods.

Minimum Flow below Whiskeytown Dam

Whiskeytown Dam is operated to meet the downstream water rights in the Clear Creek and 1963 Reclamation Proposal to USFWS and National Park Service (NPS). It is also operated to meet the predetermined CVPIA 3406(b)(2) flows, and the flow requirements identified under NMFS BO Actions I.1.1 as described in the Section 6A.9 NMFS RPA Implementation.

Shasta Lake End-of-September Minimum Storage

Shasta Lake is operated such that the end-of-September carryover storage is 1900 TAF in non-critically dry years per the NMFS 2004 Winter-run BO.

2009 NMFS BO Action 1.2.1 (Section 6A.9 NMFS RPA Implementation) requires certain storage to be met at certain percentile of all years. A post-process of operations determines whether or not these requirements are met.

Minimum Flow below Keswick Dam

Keswick Dam is operated to meet the release schedule under SWRCB WR 90-5, which maintains 3,250 cfs in the Sacramento River. It is also operated to meet pre-determined CVPIA 3406(b)(2) flows. NMFS BO Action I.2.2 includes actions that call for minimum flows to protect temperatures, as described in the Section 6A.9 NMFS RPA Implementation.

Flow Objective for Navigation at Wilkins Slough

NMFS BO Action 1.4 (Section 6A.9 NMFS RPA Implementation) requires that to conserve the cold-water pool in Shasta Lake, Wilkins Slough is operated at a flow ranging from 3,500 cfs to 5,000 cfs based on the CVP water supply condition.

Minimum Flow below Thermalito Diversion Dam

Thermalito Diversion Dam is operated to meet a minimum flow requirement of 700 cfs or 800 cfs in the Feather River low flow channel based on the 2006 Oroville Relicensing Settlement Agreement.

Minimum flow below Thermalito Afterbay Outlet

The 1983 DWR – CDFG Agreement requires a minimum flow in the Feather River below Thermalito Afterbay Outlet to be between 750 cfs and 1,700 cfs, depending on the Oroville storage condition and the forecast Feather River runoff condition.

Flow at Mouth of the Feather River

During the Feather River Service Area (FRSA) diversion season from April through September, a minimum flow of 2,800 cfs is maintained at the mouth of the Feather River depending on Lake Oroville inflow and FRSA allocation.

Minimum Flow below Nimbus Dam

Nimbus Dam is operated to meet a minimum flow requirement based on the American River Flow Management, as described in Section 6A.9 NMFS RPA Implementation under the NMFS BO Action II.1. Minimum release requirements range from 800 to 2,000 cfs based on a sequence of seasonal indices and adjustments.

American River Minimum Flow at H Street Bridge

The minimum allowable flows in the Lower American River are defined by SWRCB Decision 893 (D-893), which states that, in the interest of fish conservation, releases should not ordinarily fall below 250 cfs between January 1 and September 15 or below 500 cfs at other times.

Minimum Flow near Rio Vista

The minimum flow required on the Sacramento River at Rio Vista under the WQCP, SWRCB D-1641 is included. During September through December months, the flow requirement ranges from 3,000 cfs to 4,500 cfs, depending on the month and D-1641 40-30-30 index water year type.

Delta Outflow Index (Flow and Salinity)

SWRCB D-1641

All flow based Delta outflow requirements per SWRCB D-1641 are included in the Existing Conditions simulation. Similarly, for the February through June period X2 standard is included.

USFWS BO (December, 2008) Action 4

USFWS BO Action 4 requires additional Delta outflow to manage X2 in the fall months following the wet and above normal years to maintain average X2 for September and October no greater (more eastward) than 74 kilometers (km) in the fall following wet years and 81 km in the fall following above normal years. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin should be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall X2 target. This action is included.

Combined Old and Middle River Flows

USFWS BO restricts south Delta pumping to preserve certain Old and Middle River (OMR) flows in three of its Actions: Action 1 to protect pre-spawning adult delta smelt from entrainment during the first

flush, Action 2 to protect pre-spawning adults from entrainment and from adverse hydrodynamic conditions, and Action 3 to protect larval delta smelt from entrainment. CALSIM II simulates these actions to a limited extent.

Brief description of USFWS BO Actions 1-3 implementations in CALSIM is as follows: Action 1 is onset based on a turbidity trigger that takes place during or after December. This action requires limit on exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than 2,500 cfs (within 25 percent of the monthly criteria). Action 1 ends after 14 days of duration or when Action 3 is triggered based on a temperature criterion. Action 2 starts immediately after Action 1 and requires range of net daily OMR flows to be no more negative than -1,250 to -5,000 cfs (with a 5-day running average within 25 percent of the monthly criteria). The Action continues until Action 3 is triggered. Action 3 also requires net daily OMR flow to be no more negative than -1,250 to -5,000 cfs based on a 14-day running average (with a simultaneous 5-day running average within 25 percent). Although the range is similar to Action 2, the Action implementation is different. Action 3 continues until June 30 or when water temperature reaches a certain threshold. A more detailed description of the implementation of these actions is provided in Section 6A.8 USFWS RPA Implementation.

NMFS BO Action 4.2.3 requires OMR flow management to protect emigrating juvenile winter-run, yearling spring-run, and Central Valley steelhead within the lower Sacramento and San Joaquin rivers from entrainment into south Delta channels and at the export facilities in the south Delta. This action requires reducing exports from January 1 through June 15 to limit negative OMR flows to -2,500 to -5,000 cfs. CALSIM II assumes OMR flows required in NMFS BO are covered by OMR flow requirements developed for actions 1 through 3 of the USFWS BO as described in Section 6A.9 NMFS RPA Implementation.

South Delta Export-San Joaquin River Inflow Ratio

NMFS BO Action 4.2.1 requires exports to be capped at a certain fraction of San Joaquin River flow at Vernalis during April and May while maintaining a health and safety pumping of 1,500 cfs. This export constraint is included.

Exports at the South Delta Intakes

Exports at Jones and Banks Pumping Plant are restricted to their permitted capacities per SWRCB D-1641 requirements. In addition, the south Delta exports are subjected Vernalis flow based export limits during April and May as required Action 4.2.1. Additional 500 cfs pumping is allowed to reduce the impact of NMFS BO Action 4.2.1 on SWP during July through September period.

D-1641 1:1 CVP/SWP export limit based on the Vernalis flow from April 15 – May 15, is also included.

Under D-1641 the combined export of the CVP Tracy Pumping Plant and SWP Banks Pumping Plant is limited to a percentage of Delta inflow. The percentages range from 35 to 45 percent during February depending on the January eight river index and 35 percent during March through June months. For rest of the months 65 percent of the Delta inflow is allowed to be exported.

Delta Water Quality

No Action Alternative simulation includes compliance with the SWRCB D-1641 salinity requirements. However, not all salinity requirements are included as CALSIM II is not capable of predicting salinities in the Delta. Instead, empirically based equations and models are used to relate interior salinity conditions

with the flow conditions. DWR's Artificial Neural Network (ANN) trained for salinity is used to predict and interpret salinity conditions at Emmaton, Jersey Point, Rock Slough and Collinsville stations. Emmaton and Jersey Point standards are for protecting water quality conditions for agricultural use in the western Delta and they are in effect from April 1 to August 15. The electrical conductivity (EC) requirement at Emmaton varies from 0.45 millimhos per centimeter (mmhos/cm) to 2.78 mmhos/cm, depending on the water year type. The EC requirement at Jersey Point varies from 0.45 mmhos/cm to 2.20 mmhos/cm, depending on the water year type. Rock Slough standard of 250 milligrams per liter (mg/L) chloride is for protecting water quality conditions for M&I use for water through the Contra Costa Canal. It is a year-round standard. D-1641 also requires a certain number of days in a year with chloride concentration less than 150 mg/L. The number of days required is dependent upon the water year type. A pre-processed fixed number of days is used as input to CALSIM II to comply with 150 mg/L chloride standard at Rock Slough. Collinsville standard is applied during October through May months to protect the water quality conditions for the migrating fish species, and it varies between 12.5 mmhos/cm in May and 19.0 mmhos/cm in October.

Operations Criteria

DCC Gate Operations

SWRCB D-1641 DCC standards provide for closure of the DCC gates for fisheries protection at certain times of the year. From November through January, the DCC may be closed for up to 45 days for fishery protection purposes. From February 1 through May 20, the gates are closed for fishery protection purposes. The gates may also be closed for 14 days for fishery protection purposes during the May 21 through June 15 period. Reclamation determines the timing and duration of the closures after discussion with USFWS, CDFW, and NMFS.

NMFS BO Action 4.1.2 requires gates to be operated as described in the BO based on presence of salmonids and water quality from October 1 through December 14; and gates to be closed from December 15 to January 31, except short-term operations to maintain water quality. CALSIM II includes NMFS BO DCC gate operations in addition to the D-1641 gate operations. When the daily flows in the Sacramento River at Wilkins Slough exceed 7,500 cfs (flow assumed to flush salmon into the Delta), DCC is closed for a certain number of days in a month as described in Section 6A-9 NMFS RPA Implementation.

Allocation Decisions

CALSIM II includes allocation logic for determining deliveries to north-of-Delta and south-of-Delta CVP and SWP contractors. The delivery logic uses runoff forecast information, which incorporates uncertainty in the hydrology and standardized rule curves (i.e. Water Supply Index versus Demand Index Curve). The rule curves relate forecast water supplies to deliverable "demand," and then use deliverable "demand" to assign subsequent delivery levels to estimate the water available for delivery and carryover storage. Updates of delivery levels occur monthly from January 1 through May 1 for the SWP and March 1 through May 1 for the CVP as runoff forecasts become more certain. The south-of-Delta SWP delivery is determined based on water supply parameters and operational constraints. The CVP systemwide delivery and south-of-Delta delivery are determined similarly upon water supply parameters and operational constraints with specific consideration for export constraints.

San Luis Operations

CALSIM II sets targets for San Luis storage each month that are dependent on the current South-of-Delta allocation and upstream reservoir storage. When upstream reservoir storage is high, allocations and San Luis fill targets are increased. During a prolonged drought when upstream storage is low, allocations and fill targets are correspondingly low. The San Luis rule curve is managed to minimize situations in which shortages may occur due to lack of storage or exports.

6A.2.2 DSM2 Assumptions for Existing Conditions/No Project/No Action Condition

For the DSM2 modeling assumptions that depend upon the CALSIM II outputs, the DSM2 inputs are obtained from the appropriate CALSIM II simulation.

River Flows

For the No Action Alternative DSM2 simulation, the river flows at the DSM2 boundaries are based on the monthly flow time series from CALSIM II.

Tidal Boundary

The tidal boundary condition at Martinez is provided by an adjusted astronomical tide normalized for sea level rise (Ateljevich and Yu, 2007).

Water Quality

Martinez EC

Martinez EC boundary condition is estimated using the G-model based on the net Delta outflow simulated in CALSIM II and the pure astronomical tide (Ateljevich, 2001).

Vernalis EC

For the No Action Alternative DSM2 simulation, Vernalis EC boundary condition is based on the monthly San Joaquin EC time series estimated in CALSIM II.

Morphological Changes

No additional morphological changes were assumed as part of the Existing Conditions simulation. DSM2 model and grid developed as part of the 2009 recalibration effort (CH2M HILL, 2009) was used as part of the Existing Conditions modeling.

Facilities

DCC

DCC gate operations are modeled in DSM2. The number of days in a month the DCC gates are open is based on the monthly time series from CALSIM II.

South Delta Temporary Barriers

South Delta Temporary Barriers are included. The three agricultural temporary barriers located on Old River, Middle River and Grant Line Canal are included in the model. The fish barrier located at the Head of Old River is also included in the model.

Clifton Court Forebay Gates

Clifton Court Forebay Gates are operated based on the Priority 3 operation, where the gate operations are synchronized with the incoming tide to minimize the impacts to low water levels in nearby channels. Priority 3 operation is described in the 2008 OCAP BA Appendix F Section 5.2 (Reclamation, 2008b).

Operations Criteria

South Delta Temporary Barriers

South Delta Temporary Barriers are operated based on San Joaquin flow conditions. Head of Old River Barrier (HORB) is assumed to be only installed from September 16 to November 30 and is not installed in the spring months, based on the USFWS Delta Smelt BO Action 5. The agricultural barriers on Old and Middle rivers are assumed to be installed starting from May 16 and the one on Grant Line Canal from June 1. All three agricultural barriers are allowed to operate until November 30. The tidal gates on Old and Middle River agricultural barriers are assumed to be tied open from May 16 to May 31.

Montezuma Salinity Control Gate

The radial gates in the Montezuma Slough Salinity Control Gate Structure are assumed to be tidally operating from October through February each year, to minimize propagation of high salinity conditions into the interior Delta.

6A.3 Assumptions for Sites Reservoir EIR/EIS Alternatives Model Simulations

This section describes the CALSIM II and DSM2 modeling assumptions for Alternatives A, B, C, and D. The assumptions that are different from the Existing Conditions/No Project/No Action Condition are described below. Even though some EIR/EIS Alternative assumptions remain consistent with assumptions for the Existing Conditions/No Project/No Action Condition, they are described for completeness.

Table 6A-2 summarizes key assumptions for the EIR/EIS alternatives. As noted below, several key assumptions are common to all alternatives. For example, all alternatives include the proposed Sites Reservoir, use of Tehama-Colusa Canal up to 2,100 cfs and GCID Main Canal up to 1,800 cfs to fill Sites Reservoir, GCID Main Canal Terminal Regulating Reservoir (TRR), Tehama-Colusa Canal and GCID Main Canal intertie, and Sites Pumping Plant. Assumptions for Alternatives A, B, and C were provided by the Sites EIR/EIS Lead Agencies. For Alternative D, assumptions were provided by the Authority.

Table 6A-2
Summary of Assumptions for EIR/EIS Alternatives

Key Characteristics	Alternative A	Alternative B	Alternative C	Alternative D
Sites Reservoir				
Inundation Area	12,400 acres	14,200 acres	14,200 acres	14,200 acres
Storage Capacity	1.3 MAF	1.8 MAF	1.8 MAF	1.8 MAF
Maximum Water Surface Elev.	480 feet msl	520 feet msl	520 feet msl	520 feet msl
Conveyance Capacities *(to Sites Reservoir)*[a]				
Tehama-Colusa Canal[b]	2,100 cfs	2,100 cfs	2,100 cfs	2,100 cfs
Glenn-Colusa Irrigation District Canal	300-1800 cfs	300-1800 cfs	300-1800 cfs	300-1800 cfs

Key Characteristics	Alternative A	Alternative B	Alternative C	Alternative D
New Delevan Pipeline[c]				
Diversion	2,000 cfs	0 cfs[d]	2,000 cfs	2,000 cfs
Release	1,500 cfs	1,500 cfs	1,500 cfs	1,500 cfs
Total Diversion Capacity	5,900 cfs	3,900 cfs	5,900 cfs	5,900 cfs
Total Release Capacity	1,500 cfs	1,500 cfs	1,500 cfs	1,500 cfs

[a]Season for filling Sites Reservoir is year-round; fill operations are constrained to diversion operating criteria

[b]No Action Alternative includes the Red Bluff Pumping Plant and Fish screen with an installed capacity of 2,000 cfs. The project will install two additional pumps of 250 cfs capacity to use the full 2,100 cfs capacity for diversion of flows through the Tehama-Colusa Canal to Sites Reservoir

[c]The new Delevan Pipeline can be operated June through March (if an intake is included and diversion capacity is greater than zero, April and May are reserved for maintenance)

[d]A pump station, intake, and fish screen are not included for the new Delevan Pipeline in Alternative B; the new Delevan Pipeline can be operated for releases from Sites Reservoir to the Sacramento River year-round

Note:

msl = mean sea level

Alternative A includes a smaller Sites Reservoir with 1.3 MAF storage capacity compared to the 1.8 MAF assumed under the Alternatives B, C, and D. Alternatives A, C, and D include a pump station intake at new Delevan Pipeline, to divert up to 2,000 cfs from the Sacramento River. All four alternatives include the ability to convey up to 1,500 cfs from the Sites Reservoir to the Sacramento River through the new Delevan Pipeline.

In drought conditions, the priority operations for all alternatives are assumed to be as follows:

1. Provide water to supplement existing CVP and SWP contractors
2. Protect cold-water pool conservation in Trinity Lake, Shasta Lake, Lake Oroville, and Folsom Lake
3. Regulation of Sacramento River summer flows for best use of cold water for control of temperature conditions adverse to anadromous fish

In other hydrologic conditions (non-drought), Sites Reservoir stored water would be used to accomplish the following:

1. Provide water to supplement existing CVP and SWP contractors
2. Improve Delta water quality in the summer and fall
3. Potentially improve flows for Delta fisheries habitat through upstream actions, based on the X2 location (location of the 2 percent [parts per thousand] salinity isohaline, measured in kilometers from the Golden Gate Bridge)
4. Stabilize Sacramento River fall flows for improving spawning and rearing success of anadromous fish
5. Provide Level 4 water deliveries to wildlife refuges north and south of the Delta per CVPIA

The operational priorities to achieve the primary objectives are consistent across the four alternatives. However, Alternative D includes additional Sites Reservoir priority operations to provide water to meet unmet demands and supplement existing CVP allocations to participating CVP TCCA contractors and CVP Settlement Contractors in the Colusa Basin.

The operations priorities for the four alternatives reflect two operational modes based on hydrologic conditions, i.e. below-normal to wet hydrologic (non-drought) conditions and dry and critically dry

(drought) hydrologic conditions, based on D-1641 40-30-30 year types. In years with below normal to wet hydrologic conditions, operational priority is focused on improvement of Delta water quality, agricultural supply reliability, Level 4 refuge supplies, and Ecosystem Enhancement Storage Account (EESA) flow actions for fisheries enhancement.

Alternatively, in years under drought conditions, operations prioritize improved water supply reliability of SWP contractors and EESA storage actions which preserve cold-water availability for temperature control objectives in the Sacramento River. For EESA actions, proposed Sites Reservoir is assumed to operate cooperatively with the Shasta Lake to provide direct benefits to anadromous fish and other aquatic species in the Sacramento River and Delta ecosystem throughout all seasons of the year. Table 6A-3 shows the seasonal schedules for the key Project Operations.

All the alternatives include operational flexibility to provide water to meet additional ecosystem objectives such as the release of water through the Colusa Basin Drain into the Yolo Bypass to deliver nutrient-laden water into the Cache Slough area to increase delta smelt productivity. Operations in any given year will be a function of the current year hydrology and system conditions resulting from the previous year's hydrology and operations. The EESA provides the operational flexibility to manage a volume of water in Sites Reservoir storage to the highest priority needs on an adaptive management basis. Implementation of EESA actions to maximize ecosystem benefits would be evaluated on a continuing basis in response to changing system parameters (such as reservoir storage), ecological needs, forecasts of future hydrologic and atmospheric conditions, and system operations.

6A.3.1 Alternative A

Alternative A includes a 1.3-MAF Sites Reservoir. It relies upon the existing Tehama-Colusa Canal (2,100-cfs diversion), GCID Main Canal (1,800-cfs diversion), and the proposed Delevan Pipeline (2,000-cfs diversion) to fill the Reservoir. The proposed Delevan Pipeline (1,500-cfs release) is used to convey water from the reservoir back to the River.

6A.3.1.1 CALSIM II Assumptions for Alternative A

Facilities

Facilities assumptions under Alternative A are consistent with the No Action Alternative simulation unless noted explicitly below.

Tehama-Colusa Canal Capacity

Fish Passage Improvements at Red Bluff Pumping Plant included in the No Action Alternative allows for a pumping capacity of 2,000 cfs. Two additional pumps of 250 cfs capacity each are assumed to be installed to fully utilize the 2,100 cfs capacity of the Tehama-Colusa Canal to Sites Reservoir. The total conveyance capacity of the Tehama-Colusa Canal at the upstream end of the canal is assumed to be 2,250 cfs and 2,100 cfs at the Funks Forebay. For filling Sites Reservoir, any unused capacity remaining after the non-Sites Reservoir operations (e.g. agricultural), can be used. Approximately, additional 50 to 60 cfs of the total capacity is assumed to be used for other winter time operations of the canal.

No dedicated period for maintenance was assumed for Tehama-Colusa Canal, considering Sites Reservoir operations will likely result in one month with low flow rates through Tehama-Colusa Canal between December 1 and February 15 of every other year, and two or more months with low flow rates through Tehama-Colusa Canal between December 1 to February 15 of every fifth year.

Glenn Colusa Canal Capacity

Consistent with the No Action Alternative, 3,000 cfs of total diversion capacity is assumed at the Sacramento River intake near Hamilton City. At the TRR intertie to Funks Forebay, a capacity of 1,800 cfs is assumed for the GCID Main Canal. For filling Sites Reservoir, any unused capacity remaining after the non-Sites Reservoir operations (e.g. agricultural and refuge water supplies), can be used.

The following capacities are assumed to be used for other winter time operations of the GCID Main Canal (values in cfs).

Oct	Nov	Dec	Jan	Feb	Mar
513	534	389	235	56	48

Dedicated maintenance period was assumed for GCID Main Canal, from January 7 through February 21 of every year.

New Delevan Pipeline Diversion and Release Capacities

Alternative A includes a fish screen, pump station intake at new Delevan Pipeline, to divert up to 2,000 cfs from the Sacramento River. It also assumes an ability to convey up to 1,500 cfs of flow from the Sites Reservoir back to the Sacramento River.

Dedicated maintenance period was assumed from April 1 to May 31 under Alternative A for intake, fish screen and sediment related maintenance. Diversions or releases were not allowed during the maintenance period.

Existing Tehama-Colusa Canal- and GCID Main Canal Intertie

Consistent with the No Action Alternative, the existing Tehama-Colusa Canal and GCID Main Canal intertie provides flexibility in routing flows of up to 285 cfs, between Tehama-Colusa and GCID Main canals.

Williams Outlet

Consistent with the No Action Alternative, the Williams Outlet provides flexibility in routing flows of up to 65 cfs, between Tehama-Colusa and GCID Main canals.

Holthouse (Funks) Reservoir

The existing Funks Reservoir includes a storage capacity of 3,372 acre-feet and is part of the Tehama-Colusa Canal system. Funks Reservoir serves as a re-regulating reservoir to stabilize flows in the Tehama-Colusa Canal downstream of Funks Reservoir as diverters come on line and off line. The existing Funks Reservoir would be expanded to form the Holthouse Reservoir by constructing a new dam (Holthouse Dam) and reservoir to the east of Funks Reservoir, and breaching the existing Funks Dam so that the new and existing reservoirs would act as one unit with an enlarged active storage capacity of approximately 6,500 acre-feet. Funks Reservoir is not modeled explicitly in CALSIM II.

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Table 6A-3
Description of Seasonal Schedules for the Project Operations (Based on Table 3-24 in Chapter 3 Description of the Sites Reservoir Project Alternatives)

Objective	Detail of Operation	Priority of Operation[a]	Year Type Most Suitable for Operation[b]	Months Most Suitable for Operation[c]											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
General Operation															
Conveyance (All alternatives)	Diversions at Red Bluff (Tehama-Colusa Canal), at Hamilton City (GCID Main Canal), and at the proposed Delevan Pipeline could occur in any month. Diversions of excess flows would only be allowed once SWRCB D-1641, CVPIA 3406(b)(2), 2008 USFWS BO and 2009 NMFS BO requirements were met and SWP Article 21 demands were satisfied, and other excess Delta flow diversions (e.g., Freeport Regional Water Project, Los Vaqueros Reservoir, cities of Fairfield, Vacaville, and Benicia) were satisfied. Diversions would be restricted by Sacramento River bypass criteria at Red Bluff, Hamilton City, Wilkins Slough, and Freeport. Symbols highlight the period in which diversion operations would occur, with the November through March season having more symbols.	N/A	N/A	++	++	++	+	+	+				+	++	++
Seasonal Storage Operation (All alternatives)	Fill Sites Reservoir during excess flow events throughout the winter and spring and drain during peak release periods throughout the summer and fall. The months in which the high and low storage points would occur in the typical seasonal cycle are indicated.	N/A	N/A	Fill Cycle High Point			Drain Cycle Low Point							Fill Cycle	
Water Supply Operations															
CVP Contractors (Alternatives A, B, C)	Improve water supply reliability for CVP contractors through integrated operations with CVP facilities. Symbols indicate the typical agricultural diversion pattern.	AVG-4	AN, BN, D				++	+	+	+	++	+	+		
SWP Contractors (Alternatives A, B, C)	Improve water supply reliability for SWP contractors through integrated operations with SWP facilities.	DP-1	BN, D, C				++	++	+	++	++	+	+		
Sites Project Authority (including (Alternative D)	Provide storage releases to participating TCCA Districts on an as-needed basis to supplement CVP Agricultural Water Service Contract deliveries. Provide storage to GCID and Reclamation District 108 to supplement CVP Settlement Contract deliveries. Provide supplemental water supplied to project participants outside the Sacramento Valley to improve water supply reliability.	Authority-1	AN, BN, D, C				++	++	++	++	++	+	+		
Incremental Level 4 Water Supply for Wildlife Refuges (All alternatives)	Provide water toward meeting Incremental Level 4 wildlife refuge water needs north-of-the-Delta and south-of-the-Delta to supplement refuges supplies up to Level 4 criteria (CVPIA). Symbols highlight period in which provision of water would occur.	AVG-3	AN, BN, D									++			
Water Quality Operation															
Delta Water Quality (Alternatives A, B, C)	Improve water quality conditions at urban/municipal and industrial intakes by augmenting Delta outflow above base D-1641 operations for up to 6 months. Symbols highlight period in which Delta outflow benefits could be augmented.	AVG-1	AN, BN, D							++	++	++	++	++	+
Water Quality (Alternative D)	Upstream release actions would improve water quality conditions by augmenting Delta inflow and outflow. Operations could augment Delta flows above base D-1641 operations for up to 6 months. Symbols highlight period in which Delta benefits could be augmented.	AVG-1	AN, BN, D							++	++	++	++	++	+
Hydropower Operation															
Flexible Hydropower Generation (All alternatives)	Include dedicated pump/generation facilities with a dedicated afterbay/forebay of 6,500 acre-feet allowing more than 30 hours per week of uninterrupted operation and generation.	N/A	ALL					+	++	++	++	++	++	+	+
Ecosystem Enhancement Storage Account (EESA) Actions/Operation															
EESA-1: Shasta Coldwater Pool (All alternatives)	Improve the reliability of cold-water pool storage in Shasta Lake to increase operational flexibility to provide suitable water temperatures in the Sacramento River. This action would operationally translate into the increase of Shasta Lake May storage levels, and improved retention of cold-water pool storage, with particular emphasis on Below Normal, Dry, and Critical water year types.	DP-1	BN, D, C					+	++	++	++	++			
EESA-2: Sacramento River Flows for Temperature Control (All alternatives)	Provide releases from Shasta Dam of appropriate water temperatures, and subsequently from Keswick Dam, to improve water temperatures year-round at levels suitable for all species and life stages of anadromous salmonids in the Sacramento River between Keswick Dam and Red Bluff Pumping Plant, with particular emphasis on the months of highest potential water temperature-related impacts (i.e., July through November) during Below Normal, Dry, and Critical water year types.	DP-2	BN, D, C						+	++	++	++	+	+	

Objective	Detail of Operation	Priority of Operation[a]	Year Type Most Suitable for Operation[b]	Months Most Suitable for Operation[c]											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EESA-3: Folsom Lake Cold-Water Pool (All alternatives)	Increase the availability of cold-water pool storage in Folsom Lake, by increasing May storage and retaining cold-water pool storage, to allow additional operational flexibility to provide suitable water temperatures in the lower American River. This action would use additional cold-water pool storage by providing releases from Folsom Dam (and subsequently from Nimbus Dam) to help provide water temperatures at levels suitable for juvenile steelhead over-summer rearing and fall-run Chinook salmon spawning in the lower American River from May through November during all water year types.	DP-2	D, C					+	++	++	++	++	+	+	
EESA-4: Stabilize American River Flows (All alternatives)	Stabilize flows in the lower American River to minimize dewatering of fall-run Chinook salmon redds (i.e., October through March) and steelhead redds (i.e., January through May), and reduce juvenile anadromous salmonids isolation events, particularly from October through June. Reduce the reliance upon Folsom Lake as a "real-time first response facility" to meet Delta objectives and demands, particularly from January through August, to reduce flow fluctuation and water temperature-related impacts to fall-run Chinook salmon and steelhead in the lower American River.	DP-2	ALL	++	++	++	++	++	+	+	+		+	+	+
EESA-5: Habitat Improvement (Summer/Fall) (All alternatives)	Upstream release actions could provide supplemental flow during summer and fall months (i.e., May through December) to improve X2 position and increase estuarine habitat, reduce entrainment, and improve food availability for anadromous fishes and other estuarine-dependent species (e.g., delta smelt, longfin smelt, Sacramento splittail, starry flounder, and *Crangon franciscorum*). Shading highlights period in which flow would be augmented (operation coordinated with Water Quality action).	AVG-2	ALL					+	+	++	++	++	++	++	+
EESA-6: Lake Oroville Coldwater Pool (All alternatives)	Improve the reliability of cold-water pool storage in Lake Oroville to improve water temperature suitability for juvenile steelhead and spring-run Chinook salmon over-summer rearing and fall-run Chinook salmon spawning in the lower Feather River from May through November during all water year types. Provide releases from Oroville Dam to maintain water temperatures at levels suitable for juvenile steelhead and spring-run Chinook salmon over-summer rearing and fall-run Chinook salmon spawning in the lower Feather River. Stabilize flows in the lower Feather River to minimize redd dewatering, juvenile stranding, and isolation of anadromous salmonids.	DP-2	BN, D, C					++	++	++	++	++	+	+	+
EESA-7: Stabilize Sacramento River Fall Flows (All alternatives)	Stabilize flows in the Sacramento River between Keswick Dam and the Red Bluff Pumping Plant to minimize dewatering of fall-run Chinook salmon redds (for the spawning and embryo incubation life stage periods extending from October through March), particularly during fall months. Avoid abrupt changes. Operations would be limited to not adversely impacting cold-water pool operations in dry and critical years. Shading highlights period of greatest effect on stabilization or flows on a daily basis.	AVG-1	AN, BN, D	++	+	+						+	++	++	++
EESA-8: Sacramento River Diversion Reduction at Red Bluff and Hamilton City (All alternatives)	Provide increased flows from spring through fall in the lower Sacramento River by reducing diversions at Red Bluff Pumping Plant (into the Tehama-Colusa Canal) and at Hamilton City (into the GCID Main Canal), and by providing supplemental flows at the proposed Delevan Pipeline Intake/Discharge Facilities.	N/A	ALL				+	+	+	++	++	++	+		

[a]Priority of operation "DP" indicates that the operational priority has a driest period's emphasis and "AVG" indicates an average-to-wet hydrologic emphasis. The number 1-4 indicates priority within the associated hydrologic emphasis. "N/A" indicates that operations are not or cannot be easily defined within the priority structure of the scenario. "Authority" indicates Sites Project Authority operation on an as-needed basis subject to storage availability.

[b]Year type most suitable for operation is the D-1641 40-30-30 year types that are reflected in operations studies; operations in these year types occur when supplies would be available in Sites Reservoir to support the operation, when the operations criteria in the scenario allow for prioritization of the operations, and when conditions are suitable for developing the benefit associated with the operation.

[c]"Two symbols in the cells indicate months in which conditions would be most suitable to the operations; one symbol in the cell indicates the months that would be less suitable to the operations; operations in these months would occur when supplies are available in Sites Reservoir to support the operation, when the operations criteria in the scenario allow for prioritization of the operations, and when conditions are suitable for developing the benefit associated with the operation.

Notes:

AN = Above Normal
AVG = Average
BN = Below Normal
C = Critical
D = Dry
DP = Driest periods
GCID = Glenn-Colusa Irrigation District
NMFS = National Marine Fisheries Service
USFWS = U.S. Fish and Wildlife Service

TRR Pipeline

The proposed TRR Pipeline would be bi-directional, allowing water to be pumped from the TRR to Holthouse (Funks) Reservoir for storage, and allowing water to flow by gravity from Holthouse Reservoir for release to the TRR/GCID Main Canal. The Pipeline would have a capacity of 1,800 cfs to convey water pumped from the TRR to Holthouse Reservoir. The proposed capacity of the Pipeline to convey water by gravity flow from Holthouse Reservoir to the TRR is 900 cfs.[1]

TRR

Alternative A includes the TRR with a storage capacity 2,000 acre-feet.

Sites Reservoir

Alternative A includes the Sites Reservoir with a storage capacity of 1.3 MAF.

Regulatory Standards

Regulatory Standards under Alternative A are consistent with the No Action Alternative simulation unless noted explicitly below.

Sites Reservoir Diversions

The proposed Sites Reservoir would be filled through the diversion of excess Sacramento River water that originates from unregulated tributaries to the Sacramento River downstream from Keswick Dam. These unregulated tributaries contribute over 3 MAF of flow to the Sacramento River on an average annual basis. Therefore, less than 1 percent of diversions to Sites Reservoir are assumed to be provided by flood releases or spills that flow through Lake Shasta. Sacramento River water would be diverted at the existing Hamilton City and Red Bluff diversion locations, as well as via a new Delevan intake and pipeline for Alternative A. Excess flows are defined as river flows, in addition to those required to meet the following:

- Senior downstream water rights, existing CVP and SWP and other water rights diversions including SWP Article 21 (interruptible supply), and other more senior excess flow priorities (diversions associated with Freeport Regional Water Project and existing Los Vaqueros Reservoir)
- Existing regulatory requirements including State Water Resources Control Board D-1641, CVPIA 3406(b)(2), the 2008 USFWS BO, and the 2009 NMFS BO and other instream flow requirements
- Flow conditions needed to maintain and protect anadromous fish survival and Delta water quality

Sites Reservoir Diversion Bypass Requirements

Excess Sacramento River flow diversions to Sites Reservoir would only take place when flow at critical locations along the river is higher than the bypass flow requirements. Several existing and additional proposed bypass flow criteria were assumed at specified locations, as part of the Project. These flow criteria are designed to make certain only excess water would be diverted into Sites Reservoir to maintain and protect existing downstream water uses.

Excess Sacramento River flow diversions to Sites Reservoir would only take place when flow monitoring indicates that bypass flows are present in the river due to storm event flows. Several existing and additional proposed bypass flow criteria were assumed at specified locations. These flow criteria are

[1] The modeling assumed 1,500 cfs. When reverted to 900 cfs through sensitivity tests, the effect of this change on the modeling results was found to be negligible.

designed to make certain only excess water would be diverted into Sites Reservoir to maintain and protect existing downstream water uses, as follows:

- A bypass flow of 3,250 cfs downstream from Red Bluff Pumping Plant must be present to maintain flows in the upper Sacramento River that are required in SWRCB WR 90-5 to prevent dewatering salmonid redds and to maintain water temperatures. Diversions at Red Bluff Pumping Plant for filling Sites Reservoir would only be allowed when flows in the river are above the 3,250-cfs bypass flow criteria.
- Diversions at the Hamilton City intake for the GCID Main Canal currently require a bypass flow of 4,000 cfs to prevent fish entrainment. Diversions at Red Bluff Pumping Plant and the GCID Main Canal intake for filling Sites Reservoir would only be allowed when flows in the river are above the 4,000-cfs bypass flow requirement downstream from Hamilton City.
- Diversions for filling Sites Reservoir would only be allowed when flows below Wilkins Slough are above 5,000 cfs given the current minimum flow requirements. Wilkins Slough Navigation Control Point minimum flows currently range from 3,250 to 5,000 cfs depending on hydrologic conditions.
- Diversions for filling Sites Reservoir would only be allowed when a Sacramento River flow of 15,000 cfs is present at Freeport in January, 13,000 cfs in December and February through June, and 11,000 cfs in all other months. This flow threshold was designed to protect and maintain existing downstream water uses and water quality in the Delta.

Pulse Flow Protection Diversion Assumptions

Operations modeling of the Project included restrictions on diversions to limit impacts on out-migrating juvenile fish as a "surrogate" for likely permit conditions. Based on recent literature and the proposed permit conditions for other diversion projects, pulse flow events are found to stimulate the observed spike in juvenile salmon out-migration. Operations modeling for the Project diversions were assumed to be restricted to minimize impacts to fish passage associated with simulated pulse flow events. Actual operations are anticipated to be informed by real-time monitoring of fish movement.

The assumed limits on diversions during naturally occurring, storm-induced pulse flow events in the Sacramento River were based on a recent study by del Rosario et al. (2013), which found an abrupt and substantial spike in winter-run Chinook salmon arrivals at Knights Landing in association with the first storm event producing a flow of 400 cubic meters per second (14,126 cfs) at Wilkins Slough. This spike was followed shortly by passage of up to the 50th percentile of cumulative migration. This relationship was apparent for a wide range of water year types, based on catch data collected between 1999 and 2007.

Accordingly, an assumed pulse protection period was developed that would extend from October through May to address out-migration of juvenile winter-, spring-, fall- and late-fall-run Chinook salmon as well as steelhead. Pulse flows during this period would provide flow continuity between the upper and lower Sacramento River to support fish migration. It is recognized that research regarding the benefits of pulse flows is ongoing, and further research and adaptive management would be required to develop and refine a pulse flow protection strategy for fish migration. Therefore, this assumption was used for modeling and informational purposes only.

For proposed Sites Reservoir operations, pulse flows are defined by extended peak river flows at Bend Bridge that originate primarily from storm event tributary inflows downstream from Keswick Dam. For the purposes of operations modeling, a naturally occurring pulse event was considered initiated when the 3-day running average flow below Bend Bridge exceeded 15,000 cfs. Such an event would need to continue for at least a 7-day duration to be considered a qualified storm event for the simulation process.

Diversions to Sites Reservoir would not be allowed during the 7-day period that flow is greater than 15,000 cfs. The duration of a pulse flow event would be considered terminated under the following conditions: 1) the 3-day running average discharge flow remained greater than 15,000 cfs for 7 days after initiation, 2) the 3-day running average discharge flow dropped below 15,000 cfs before reaching the 7-day duration, or 3) the 3-day running average discharge flow exceeded 25,000 cfs before reaching the 7-day duration.

Given that del Rosario et al. (2013) indicate that the first storm event was associated with a spike in salmon arrivals at Knights Landing, diversions to Sites Reservoir would not be allowed during the first 7-day qualified pulse period, when flows reach 15,000 cfs during the out-migration season. For evaluation of Sites Project Reservoir operations, it was assumed that up to one qualified 7-day pulse event would occur each month during the pulse protection period (October through May) to encourage and support salmonid out-migration and minimize potential diversion impacts. Therefore, for operations modeling, diversions to Sites Reservoir storage would be restricted under the following conditions: 1) if pulse conditions exist at Bend Bridge and a qualified pulse event has not already occurred within the given month; and 2) if Bend Bridge flows are less than 25,000 cfs during the pulse event. Diversions are allowed when flows exceed 25,000 cfs, because flows of this magnitude are considered to provide lesser benefits to fish migration.

Operations Criteria

Operations criteria under Alternative A are consistent with the No Action Alternative simulation unless noted explicitly below.

Diversions to Fill Sites Reservoir Storage

Diversions to Sites Reservoir storage using existing Tehama-Colusa and GCID Main canals conveyance are allowed year-round if the bypass flow criteria noted above is first met. The deliveries for TCCA and GCID service areas have priority for using the canals. Diversion to Sites Reservoir will utilize the unused capacities of these two canals.

Under Alternative A, diversions through the new Delevan Pipeline are allowed year-round assuming Sacramento River flow conditions are above the bypass flow criteria described above. In summer months, preference would generally be given to Sites Reservoir releases to the river, resulting in limited diversions to storage, given the pipeline could only convey flows in one direction at a time.

Releases from Sites Reservoir Storage

Direct releases of water from Sites Reservoir to the Sacramento River are limited by the release capacity of the new Delevan Pipeline, 1,500 cfs, and exchanges of CVP stored water for reduction of Tehama-Colusa Canal (Red Bluff) and GCID Main Canal (Hamilton City) diversions (only available during agricultural irrigation season). During peak irrigation season when demands for water is high for TCCA and GCID users, the maximum quantity of water that Sites Reservoir can release to meet TCCA and GCID users demands downstream of Funks Reservoir and the TRR is 3,400 cfs.

Indirect releases can occur through cooperative operations between Shasta Lake and Sites Reservoir. The use of Shasta Lake for this purpose is limited to avoid impacts on cold-water pool and temperature objectives (Trinity Lake and Shasta Lake must have combined 3.4 MAF of storage at the time of the coordinated operation of indirect releases).

Shasta Lake Cold-water Pool Improvement

A priority action included in the EESA list is the reoperation of the Sacramento River to improve the reliability of cold-water carryover storage at Shasta Lake. Sites Reservoir and Shasta Lake can be operated cooperatively to improve the reliability of Shasta Lake cold-water pool during summer months and in years with driest hydrologic conditions.

Sites Reservoir provides an alternate source of supply to directly manage lower Sacramento River flows, Delta flow and export requirements. In addition, through cooperative operation for these requirements, releases from Trinity Lake, Shasta Lake, Lake Oroville and Folsom Lake can be reduced at times to increase the carryover storage in any one of these reservoirs. Through direct release operations from Sites Reservoir and through reduction of TCCA and GCID diversions at Tehama-Colusa Canal (Red Bluff) and GCID Main Canal (Hamilton City) through exchange of storage releases for diversion reductions during summer irrigation months, release requirements from Shasta Lake can be reduced.

To minimize potential adverse effects on Shasta Lake carryover storage, a combined Trinity Lake and Shasta Lake carryover storage target of 3,400 TAF is assumed for releases from Shasta Lake are made in cooperation with Sites Reservoir operations. This target is considered in decisions regarding Shasta Lake releases for all ecosystem enhancement actions (most of these require releases from Shasta Lake) as well as use of Shasta Lake releases for other non-CVP uses.

Sacramento River Supplement Flows for Temperature Control

This action is a companion to improving the reliability of cold-water carryover storage at Shasta Lake and includes managing of Keswick Dam releases for improved temperature and habitat conditions on the Sacramento River between Keswick and Red Bluff Pumping Plant.

As stated previously, Sites Reservoir and Shasta Lake can be operated cooperatively to improve the reliability of Shasta Lake cold-water pool during summer months and in years with driest hydrologic conditions. This improved cold-water pool is achieved through improved flexibility in managing Shasta Lake releases. Through additional flexibility, releases can be effectively managed to benefit salmon.

Shasta Lake cold-water pool conditions are limited by the amount of carryover storage from the previous year and the ability to manage flows through the summer. The operations under Alternative A are designed to achieve a trade-off between releases for temperature control in a critically dry year as well as leaving water in storage for carryover in case the next year is critically dry as well.

Folsom Lake Cold-water Pool Improvement

This action is to improve the reliability of cold-water carryover storage in May at Folsom Lake to increase operational flexibility and provide appropriate flows with suitable water temperatures and stabilize flows in the lower American River. The ability to achieve this action depends on cooperatively operating the Sites Reservoir and Folsom Lake.

Delta Water Quality *and Delta Outflow Improvement*

This upstream action results in supplemental Delta outflow during summer and fall months (i.e., June through December) in all water year types to improve X2 (if possible, to west of Collinsville, 81 km) and to increase estuarine habitat, reduce entrainment, and improve food availability for anadromous fishes and other estuarine-dependent species (e.g., delta smelt, longfin smelt, Sacramento splittail, starry flounder, and shrimp [*Crangon franciscorum*]). Delta water quality improvements are derived from such upstream releases by controlling salinity intrusion.

When Sites Reservoir has stored water available for improving Delta water quality, releases to augment Delta outflow would be made over a 6-month period from June through September and November through December. The average monthly release rates for this purpose vary between 500 cfs and 1,500 cfs in June through September and 1,000 cfs in November through December; releases for Delta water quality are triggered by Rock Slough chloride levels. Specific water quality release criteria are shown in Table 6A-4.

Table 6A-4
Water Quality Release Criteria

Periods (month)	Rock Slough Chloride (mg/L)	Sites Reservoir Release (cfs)
June	>23	500
July, August, September	>23	1,500
November, December	> 50	1,000

Lake Oroville Cold-water Pool Improvement

This action is to improve the reliability of cold-water pool storage in Oroville Reservoir to improve water temperature suitability for juvenile steelhead and spring-run Chinook salmon over-summer rearing, and fall-run Chinook salmon spawning in the lower Feather River from June through September and in years with driest hydrologic conditions. Manage releases from Oroville Dam to maintain mean daily water temperatures at levels suitable for juvenile steelhead and spring-run Chinook salmon over-summer rearing, and fall-run Chinook salmon spawning in the lower Feather River. Stabilize flows in the lower Feather River to minimize redd dewatering, juvenile stranding and isolation of anadromous salmonids.

Stabilize Sacramento River Fall Flows

This action is to stabilize fall flows between Keswick Dam and Red Bluff to avoid abrupt reductions through additional Keswick releases in all years except under the driest hydrologic conditions. This action is intended to reduce adverse conditions for spawning fall-run Chinook salmon (i.e., dewatering of redds, scour damage, etc.).

Sacramento River Diversion Reductions at Red Bluff and Hamilton City

This action is to maintain increased flows from spring through fall in the lower Sacramento River by reducing diversions at Red Bluff Pumping Plant (into the Tehama-Colusa Canal) and at Hamilton City (into the GCID Main Canal) and by providing supplemental flows through the new Delevan Pipeline.

Many of the potential benefits of Sites Reservoir are dependent not only on the ability to make direct releases to the Sacramento River through the new Delevan pipeline but also to make releases from Shasta Lake or through reductions in Tehama-Colusa Canal and GCID Main Canal diversions at Red Bluff and Hamilton City intakes. Reductions in Tehama-Colusa Canal and GCID Main Canal diversions are achieved through exchange with releases from Sites Reservoir to meet local demands in the Colusa Basin.

The exchange of releases from Sites Reservoir to local Colusa Basin demands for reductions in Sacramento River diversions has been a mechanism through which to maintain benefits of the project operations without requiring large conveyance capacities (that would otherwise be required if reductions in diversions and other exchanges were not included).

6A.3.2 Alternative B

Alternative B includes a 1.8-MAF Sites Reservoir. It relies upon the existing Tehama-Colusa Canal (2,100-cfs diversion) and GCID Main Canal (1,800-cfs diversion) diversion intakes to fill the Reservoir. The proposed Delevan Pipeline (1,500-cfs release) is only used to convey water from the Sites Reservoir back to the River. The diversion intake is not included in the Alternative B.

6A.3.2.1 CALSIM II Assumptions for Alternative B

Facilities

Facilities assumptions under Alternative B are consistent with the Alternative A simulation unless noted explicitly, below.

Tehama-Colusa Canal Capacity

Consistent with Alternative A.

GCID Main Canal Capacity

Consistent with Alternative A.

New Delevan Pipeline Diversion and Release Capacities

Alternative B does not include the Delevan Pipeline intake to divert water to Sites Reservoir. The new Delevan Pipeline is assumed to only convey up to 1,500 cfs of flow from the Sites Reservoir back to the Sacramento River. Dedicated maintenance period is not required for the Delevan Pipeline under Alternative B since the intake and fish screen are not included in this alternative.

Existing Tehama-Colusa Canal and GCID Main Canal Intertie

Consistent with Alternative A.

Williams Outlet

Consistent with Alternative A.

Holthouse (Funks) Reservoir

Consistent with Alternative A.

TRR Pipeline

Consistent with Alternative A.

TRR

Consistent with Alternative A.

Sites Reservoir

Alternative B includes the Sites Reservoir with a storage capacity of 1.8 MAF.

Regulatory Standards

Regulatory Standards under Alternative B are consistent with the Alternative A simulation unless noted explicitly below.

Sites Reservoir Diversions

Consistent with Alternative A.

Sites Reservoir Diversion Bypass Requirements

Consistent with Alternative A.

Pulse Flow Protection Assumptions

Consistent with Alternative A.

Operations Criteria

Operations criteria under Alternative B are consistent with the Alternative A simulation unless noted explicitly below.

Diversions to Fill Sites Reservoir Storage

Consistent with Alternative A, diversions to Sites Reservoir storage using existing Tehama-Colusa Canal and GCID Main Canal conveyance are allowed year-round if the bypass flow criteria noted above is first met. The deliveries for TCCA and GCID service areas have first priority for using the canals. Diversion to Sites Reservoir will utilize the unused capacities of these two canals. Alternative B does not include the proposed third intake at the Delevan Pipeline.

Releases from Sites Reservoir Storage

Consistent with Alternative A.

Shasta Lake Cold-water Pool Improvement

Consistent with Alternative A.

Sacramento River Supplement Flows for Temperature Control

Consistent with Alternative A.

Folsom Lake Cold-water Pool Improvement

Consistent with Alternative A.

Delta Outflow Improvement

Consistent with Alternative A.

Delta Water Quality

Consistent with Alternative A.

Lake Oroville Cold-water Pool Improvement

Consistent with Alternative A.

Stabilize Sacramento River Fall Flows

Consistent with Alternative A.

Sacramento River Diversion Reductions at Red Bluff and Hamilton City

Consistent with Alternative A.

6A.3.3 Alternative C

Alternative C includes a 1.8-MAF Sites Reservoir. It relies upon the existing Tehama-Colusa Canal (2,100-cfs diversion), GCID Main Canal (1,800-cfs diversion), and the proposed Delevan Pipeline

(2,000-cfs diversion) to fill the Reservoir. The proposed Delevan Pipeline (1,500-cfs release) is used to convey water from the reservoir back to the River.

6A.3.3.1 CALSIM II Assumptions for Alternative C

Facilities

Facilities assumptions under Alternative C are consistent with the Alternative A simulation unless noted explicitly, below.

Tehama-Colusa Canal Capacity

Consistent with Alternative A.

GCID Main Canal Capacity

Consistent with Alternative A.

New Delevan Pipeline Diversion and Release Capacities

Consistent with Alternative A.

Existing Tehama-Colusa Canal and GCID Main Canal Intertie

Consistent with Alternative A.

Williams Outlet

Consistent with Alternative A.

Holthouse (Funks) Reservoir

Consistent with Alternative A.

TRR Pipeline

Consistent with Alternative A.

TRR

Consistent with Alternative A.

Sites Reservoir

Alternative C includes the Sites Reservoir with a storage capacity of 1.8 MAF.

Regulatory Standards

Regulatory Standards under Alternative C are consistent with the Alternative A simulation unless noted explicitly, below.

Sites Reservoir Diversions

Consistent with Alternative A.

Sites Reservoir Diversion Bypass Requirements

Consistent with Alternative A.

Pulse Flow Protection Assumptions

Consistent with Alternative A.

Operations Criteria

Operations criteria under Alternative C are consistent with the Alternative A simulation unless noted explicitly, below.

Diversions to Fill Sites Reservoir Storage

Consistent with Alternative A.

Releases from Sites Reservoir Storage

Consistent with Alternative A.

Shasta Lake Cold-water Pool Improvement

Consistent with Alternative A.

Sacramento River Supplement Flows for Temperature Control

Consistent with Alternative A.

Folsom Lake Cold-water Pool Improvement

Consistent with Alternative A.

Delta Outflow Improvement

Consistent with Alternative A.

Delta Water Quality

Consistent with Alternative A.

Lake Oroville Cold-water Pool Improvement

Consistent with Alternative A.

Stabilize Sacramento River Fall Flows

Consistent with Alternative A.

Sacramento River Diversion Reductions at Red Bluff and Hamilton City

Consistent with Alternative A.

6A.3.4 Alternative D

Alternative D includes a 1.8-MAF Sites Reservoir. It relies upon the existing Tehama-Colusa Canal (2,100-cfs diversion), GCID Main Canal (1,800-cfs diversion), and the proposed Delevan Pipeline (2,000-cfs diversion) to fill the Reservoir. The proposed Delevan Pipeline (1,500-cfs release) is used to convey water from the reservoir back to the River. A total of 480 TAF of Sites Reservoir storage is reserved for project participants local to the Colusa Basin.

6A.3.4.1 CALSIM II Assumptions for Alternative D

Facilities

Facilities assumptions under Alternative D are consistent with the Alternative A simulation unless noted explicitly.

Tehama-Colusa Canal Capacity

Consistent with Alternative A.

GCID Main Canal Capacity

Consistent with Alternative A.

New Delevan Pipeline Diversion and Release Capacities

Consistent with Alternative A.

Existing Tehama-Colusa Canal and GCID Main Canal Intertie

Consistent with Alternative A.

Williams Outlet

Consistent with Alternative A.

Holthouse (Funks) Reservoir

Consistent with Alternative A.

TRR Pipeline

Consistent with Alternative A.

TRR

Alternative D includes the TRR with a storage capacity of 1,200 acre-feet.

Sites Reservoir

Alternative D includes the Sites Reservoir with a storage capacity of 1.8 MAF.

Regulatory Standards

Regulatory Standards under Alternative D are consistent with the Alternative A simulation unless noted explicitly, below.

Sites Reservoir Diversions

Consistent with Alternative A.

Sites Reservoir Diversion Bypass Requirements

Consistent with Alternative A.

Pulse Flow Protection Assumptions

Consistent with Alternative A.

Operations Criteria

Operations criteria under Alternative D are consistent with the Alternative A simulation unless noted explicitly, below.

Diversions to Fill Sites Reservoir Storage

Consistent with Alternative A.

Releases from Sites Reservoir Storage

Consistent with Alternative A.

Sites Reservoir Local Storage Account

In Alternative D, a local storage account is assumed to provide Sites Reservoir supply to meet Sites Reservoir participants' needs in the Colusa Basin. A total of 480 TAF of storage capacity out of the total storage of 1.8 MAF is assumed to support local needs.

The TCCA sub-account is 400 TAF and is used to meet demands not met by CVP deliveries up to 100 percent of the participants' CVP service contract amount. GCID and RD 108 each has 40 TAF sub-accounts. The intended use of the GCID and RD 108 sub-accounts is to provide 20 TAF per year to each district when CVP settlement contractor deliveries are reduced. In non-critical water years, up to 20 TAF may be transferred to other users depending on unmet system water demands.

Shasta Lake Cold-water Pool Improvement

Consistent with Alternative A.

Sacramento River Supplement Flows for Temperature Control

Consistent with Alternative A.

Folsom Lake Cold-water Pool Improvement

Consistent with Alternative A.

Delta Outflow Improvement

Consistent with Alternative A.

Delta Water Quality

Consistent with Alternative A.

Lake Oroville Cold-water Pool Improvement

Consistent with Alternative A.

Stabilize Sacramento River Fall Flows

Consistent with Alternative A.

Sacramento River Diversion Reductions at Red Bluff and Hamilton City

Consistent with Alternative A.

6A.4 Existing Conditions/No Project/No Action Condition Modeling Assumptions Callout Tables

6A.4.1 CALSIM II Assumptions

This subsection provides a summary of the CALSIM II assumptions for the Existing Conditions/No Project/ No Action Condition. These assumptions were selected by DWR and Reclamation management team for the NODOS EIR/EIS in coordination with USFWS and NMFS. The assumptions for each scenario are listed in Table 6A-5. The information included here is consistent with what was provided to and agreed to by the NODOS EIR/EIS management team on October 1, 2010. Even though these tables show different assumptions for the Existing Conditions and the No Action Alternative, as noted in Section 6A.2 Assumptions for Existing Conditions/No Project/No Action Condition Model Simulations, the No Action Alternative was used to represent the Existing Conditions/No Project/No Action Condition in the Sites Reservoir Draft EIR/EIS.

6A.4.2 DSM2 Assumptions

This subsection provides a summary of the DSM2 assumptions for the Existing Condition and No Action Alternative. These assumptions were selected by DWR and Reclamation management team for the NODOS EIR/EIS in coordination with USFWS and NMFS. The assumptions for each scenario are listed in Table 6A-6. The information included in here is consistent with what was provided to and agreed to by NODOS EIR/EIS management team on October 1, 2010. Even though these tables show different assumptions for the Existing Conditions and the No Action Alternative, as noted in Section 6A.2 Assumptions for Existing Conditions/No Project/No Action Condition Model Simulations, the No Action Alternative was used to represent the Existing Conditions/No Project/No Action Condition in the Sites Reservoir Draft EIR/EIS.

Table 6A-5
CALSIM II Assumptions

In Table 6A-5, the column identified as "No Action Alternative Assumption" represents the "Existing Conditions/No Project/No Action Condition" in the Sites Reservoir EIR/EIS.

	Existing Condition Assumption	No Action Alternative Assumption
Planning Horizon[a]	Year 2009	Year 2030 through Year 2120 (NODOS EIR/EIS and Feasibility Report planning period)
Demarcation Date[a]	February 2009 (but with June 2009 NMFS BO included)	Same
Period of Simulation	82 years (1922–2003)	Same
HYDROLOGY		
Inflows/Supplies	Historical with modifications for operations upstream of rim reservoirs	Historical with modifications for operations upstream of rim reservoirs
Level of development	Projected 2005 level[b]	Projected 2030 level[c]
DEMANDS, WATER RIGHTS, CVP/SWP CONTRACTS		
Sacramento River Region (excluding American River)		
CVP[d]	Land-use based, limited by contract amounts	Land-use based, full build-out of contract amounts
SWP (FRSA)[e]	Land-use based, limited by contract amounts	Same
Non-project	Land use based, limited by water rights and SWRCB Decisions for Existing Facilities	Same
Antioch Water Works	Pre-1914 water right	Same
Federal refuges[f]	Recent historical Level 2 water needs	Firm Level 2 water needs
Sacramento River Region – American River[g]		
Water rights	Year 2005	Year 2025, full water rights
CVP	Year 2005	Year 2025, full contracts, including Freeport Regional Water Project
San Joaquin River Region[h]		
Friant Unit	Limited by contract amounts, based on current allocation policy	Same
Lower Basin	Land-use based, based on district level operations and constraints	Same

	Existing Condition Assumption	No Action Alternative Assumption
Stanislaus River[i]	Land-use based, Revised Operations Plan[t] and NMFS BO (June 2009) Actions III.1.2 and III.1.3[v]	Same
San Francisco Bay, Central Coast, Tulare Lake, and South Coast Regions (CVP/SWP project facilities)		
CVP[d]	Demand based on contract amounts	Same
CCWD[j]	195 TAF/year CVP contract supply and water rights	Same
SWP[e,k]	Variable demand, of 3.0-4.1 MAF/year, up to Table A amounts including all Table A transfers through 2008	Demand based on Table A amounts
Article 56	Based on 2001-08 contractor requests	Same
Article 21	Metropolitan Water District demand up to 200 TAF/month from December to March subject to conveyance capacity, Kern County Water Agency demand up to 180 TAF/month, and other contractor demands up to 34 TAF/month in all months, subject to conveyance capacity	Same
North Bay Aqueduct	71 TAF/year demand under SWP contracts, up to 43.7 cfs of excess flow under Fairfield, Vacaville and Benicia Settlement Agreement	77 TAF/year demand under SWP contracts, up to 43.7 cfs of excess flow under Fairfield, Vacaville and Benicia Settlement Agreement
Federal refuges[f]	Recent historical Level 2 water needs	Firm Level 2 water needs
FACILITIES		
System-wide	Existing facilities	Same
Sacramento River Region		
Shasta Lake	Existing, 4,552 TAF capacity	Same
Red Bluff Pumping Plant	Diversion dam operated gates out, except June 15 – August 31 based on NMFS BO (June 2009) Action I.3.2[v]; assume interim/ temporary facilities in place	Diversion dam operated with gates out all year, NMFS BO (June 2009) Action I.3.1[v]; assume permanent facilities in place
Colusa Basin	Existing conveyance and storage facilities	Same
Upper American River[g,l]	PCWA American River Pump Station	Same
Lower Sacramento River	None	Freeport Regional Water Project[n]
San Joaquin River Region		
Millerton Lake (Friant Dam)	Existing, 520-TAF capacity	Same
Lower San Joaquin River	None	City of Stockton Delta Water Supply Project, 30-million-gallon-per-day capacity

	Existing Condition Assumption	No Action Alternative Assumption
Delta Region		
SWP Banks Pumping Plant (South Delta)	Physical capacity is 10,300 cfs but 6,680 cfs permitted capacity in all months up to 8,500 cfs during December 15 – March 15 depending on Vernalis flow conditions[o]; additional capacity of 500 cfs (up to 7,180 cfs) allowed for July – September for reducing impact of NMFS BO (June 2009) Action IV.2.1[v] on SWP[w]	Same
CVP C.W. Bill Jones Pumping Plant (Tracy Pumping Plant)	Permit capacity is 4,600 cfs but exports limited to 4,200 cfs plus diversions upstream of Delta Mendota Canal constriction	Permit capacity is 4,600 cfs in all months (allowed for by the Delta-Mendota Canal–California Aqueduct Intertie)
Upper Delta-Mendota Canal Capacity	Existing	Existing plus 400 cfs Delta-Mendota Canal–California Aqueduct Intertie
CCWD Intakes	Los Vaqueros existing storage capacity, 100 TAF, existing pump locations	Los Vaqueros expanded storage capacity, 160 TAF, existing pump locations, Alternative Intake Project included[p]
San Francisco Bay Region		
South Bay Aqueduct	Existing capacity	South Bay Aqueduct rehabilitation, 430 cfs capacity from junction with California Aqueduct to Alameda County Flood Control and Water Conservation District Zone 7 diversion point
South Coast Region		
California Aqueduct East Branch	Existing capacity	Same
REGULATORY STANDARDS		
North Coast Region		
Trinity River		
Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/year)	Same
Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same
Sacramento River Region		
Clear Creek		
Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 Reclamation Proposal to USFWS and NPS, predetermined CVPIA 3406(b)(2) flows[q], and NMFS BO (June 2009) Action I.1.1[v]	Same
Upper Sacramento River		

	Existing Condition Assumption	No Action Alternative Assumption
Shasta Lake end-of-September minimum storage	NMFS 2004 Winter-run BO, (1,900 TAF in non-critically dry years), and NMFS BO (June 2009) Action I.2.1[v]	Same
Minimum flow below Keswick Dam	SWRCB WR 90-5, predetermined CVPIA 3406(b)(2) flows[q], and NMFS BO (June 2009) Action I.2.2[v]	Same
Feather River		
Minimum flow below Thermalito Diversion Dam	2006 Settlement Agreement (700 / 800 cfs)	Same
Minimum flow below Thermalito Afterbay outlet	1983 DWR - CDFG Agreement (750-1,700 cfs)	Same
Yuba River		
Minimum flow below Daguerre Point Dam	D-1644 Operations (Lower Yuba River Accord)[r]	Same
American River		
Minimum flow below Nimbus Dam	American River Flow Management[s] as required by NMFS BO (June 2009) Action II.1[v]	Same
Minimum Flow at H Street Bridge	SWRCB D-893	Same
Lower Sacramento River		
Minimum flow near Rio Vista	SWRCB D-1641	Same
San Joaquin River Region		
Mokelumne River		
Minimum flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 cfs)	Same
Minimum flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 cfs)	Same
Stanislaus River		
Minimum flow below Goodwin Dam	1987 Reclamation, CDFG agreement, and flows required for NMFS BO (June 2009) Action III.1.2 and III.1.3[v]	Same
Minimum dissolved oxygen	SWRCB D-1422	Same
Merced River		
Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov-Mar), and Cowell Agreement	Same
Minimum flow at Shaffer Bridge	FERC 2179 (25-100 cfs)	Same

	Existing Condition Assumption	No Action Alternative Assumption
Tuolumne River		
Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/year)	Same
San Joaquin River		
San Joaquin River below Friant Dam/ Mendota Pool	Water Year 2010 Interim Flows Project [u]	Same
Maximum salinity near Vernalis	SWRCB D-1641	Same
Minimum flow near Vernalis	SWRCB D-1641, and NMFS BO (June 2009) Action IV.2.1[v]	Same
Sacramento River – San Joaquin Delta Region		
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641 and USFWS BO (December 2008) Action 4	Same
DCC gate operation	SRWCB D-1641 with additional days closed from October 1 – January 31 based on NMFS BO (June 2009) Action IV.1.2[v] (closed during flushing flows from October 1 – December 14 unless adverse water quality conditions)	Same
South Delta exports (Jones Pumping Plant and Banks Pumping Plant)	SWRCB D-1641, Vernalis flow-based export limits April 1 – May 31 as required by NMFS BO (Jun, 2009) Action IV.2.1[v] (additional 500 cfs allowed for July – September for reducing impact on SWP)[w]	Same
Combined Flow in OMR	USFWS BO (December 2008) Actions 1 through 3 and NMFS BO (June 2009) Action IV.2.3[v]	Same
OPERATIONS CRITERIA: RIVER-SPECIFIC		
Sacramento River Region		
Upper Sacramento River		
Flow objective for navigation (Wilkins Slough)	NMFS BO (June 2009) Action I.4[v]; 3,500 – 5,000 cfs based on CVP water supply condition	Same
American River		
Folsom Dam flood control	Variable 400/670 flood control diagram (without outlet modifications)	Same
Feather River		
Flow at Mouth of Feather River (above Verona)	Maintain CDFW/DWR flow target of 2,800 cfs for April – September dependent on Oroville inflow and FRSA allocation	Same
San Joaquin River Region		
Stanislaus River		
Flow below Goodwin Dam[i]	Revised Operations Plan[t] and NMFS BO (June 2009) Action III.1.2 and III.1.3[v]	Same

	Existing Condition Assumption	No Action Alternative Assumption
San Joaquin River		
Salinity at Vernalis	Grasslands Bypass Project (partial implementation)	Grasslands Bypass Project (full implementation)
OPERATIONS CRITERIA: SYSTEMWIDE		
CVP Water Allocation		
Settlement / Exchange	100% (75% in Shasta critical[y] years)	Same
Refuges	100% (75% in Shasta critical[y] years)	Same
Agriculture Service	100%–0% based on supply, South-of-Delta allocations are additionally limited due to D-1641, USFWS BO (December 2008) and NMFS BO (June 2009) export restrictions[v]	Same
Municipal & Industrial Service	100%-50% based on supply, South-of-Delta allocations are additionally limited due to D-1641, USFWS BO (December 2008) and NMFS BO (June 2009) export restrictions[v]	Same
SWP Water Allocation		
North of Delta (FRSA)	Contract specific	Same
South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement; allocations are additionally limited due to D-1641 and USFWS BO (December 2008) and NMFS BO (June 2009) export restrictions[v]	Same
CVP–SWP Coordinated Operations		
Sharing of responsibility for in-basin-use	1986 Coordinated Operations Agreement (FRWP EBMUD and 2/3 of the North Bay Aqueduct diversions considered as Delta Export; 1/3 of the North Bay Aqueduct diversion as in-basin-use)	Same
Sharing of surplus flows	1986 Coordinated Operations Agreement	Same
Sharing of total allowable export capacity for project-specific priority pumping	Equal sharing of export capacity under SWRCB D-1641, USFWS BO (December 2008) and NMFS BO (June 2009) export restrictions[v]	Same
Water transfers	Acquisitions by SWP contractors are wheeled at priority in Banks Pumping Plant over non-SWP users; Lower Yuba River Accord included for SWP contractors[w]	Same
Sharing of total allowable export capacity for lesser priority and wheeling-related pumping	Cross Valley Canal wheeling (max of 128 TAF/year), CALFED ROD defined Joint Point of Diversion	Same
San Luis Reservoir	San Luis Reservoir is allowed to operate to a minimum storage of 100 TAF	Same

	Existing Condition Assumption	No Action Alternative Assumption
CVPIA 3406(b)(2)[v,q]		
Policy Decision	Per May 2003 Dept. of Interior Decision:	Same
Allocation	800 TAF, 700 TAF in 40-30-30 dry years, and 600 TAF in 40-30-30 critical years as a function of Ag allocation	Same
Actions	Pre-determined upstream fish flow objectives below Whiskeytown and Keswick Dams, non-discretionary NMFS BO (June 2009) actions for the American and Stanislaus Rivers, and NMFS BO (June 2009) and USFWS BO (December 2008) actions leading to export restrictions[v]	Same
Accounting	Releases for non-discretionary USFWS BO (December 2008) and NMFS BO (June 2009)[v] actions may or may not always be deemed (b)(2) actions; in general, it is anticipated, that accounting of these actions using (b)(2) metrics, the sum would exceed the (b)(2) allocation in many years; therefore, no additional actions are considered and no accounting logic is included in the model [q]	Same
WATER MANAGEMENT ACTIONS		
Water Transfer Supplies (long-term programs)		
Lower Yuba River Accord[w]	Yuba River acquisitions for reducing impact of NMFS BO export restrictions[v] on SWP	Same
Phase 8	None	None
Water Transfers (short-term or temporary programs)		
Sacramento Valley acquisitions conveyed through Banks Pumping Plant[x]	Post-analysis of available capacity	Post-analysis of available capacity

[a]These assumptions have been developed under the direction of DWR and Reclamation management team for the NODOS EIR/EIS.

[b]The Sacramento Valley hydrology used in the Existing Conditions CALSIM II model reflects nominal 2005 land-use assumptions. The nominal 2005 land-use was determined by interpolation between the 1995 and projected 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects 2005 land-use assumptions developed by Reclamation. Existing-level projected land-use assumptions are being coordinated with the California Water Plan Update for future models.

[c]The Sacramento Valley hydrology used in the No Action Alternative CALSIM II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation. Development of Future-level projected land-use assumptions are being coordinated with the California Water Plan Update for future models.

[d]CVP contract amounts have been updated according to existing and amended contracts as appropriate. Assumptions regarding CVP agricultural and M&I service contracts and Settlement Contract amounts are documented in the Delivery Specifications attachments (Attachment 6A-1).

[e]SWP contract amounts have been updated as appropriate based on recent Table A transfers/agreements. Assumptions regarding SWP agricultural and M&I contract amounts are documented in the Delivery Specifications attachments (Attachment 6A-1).

[f]Water needs for federal refuges have been reviewed and updated as appropriate. Assumptions regarding firm Level 2 refuge water needs are documented in the Delivery Specifications attachments (Attachment 6A-1). Refuge Level 4 (and incremental Level 4) water is not analyzed.

[g]Assumptions regarding American River water rights and CVP contracts are documented in the Delivery Specifications attachments (Attachment 6A-1). The Sacramento Area Water Forum agreement, its dry year diversion reductions, Middle Fork Project operations and "mitigation" water is not included.

[h]The new CALSIM II representation of the San Joaquin River has been included in this model package (CALSIM II San Joaquin River Model, Reclamation, 2005). Updates to the San Joaquin River have been included since the preliminary model release in August 2005. The model reflects the difficulties of on-going groundwater overdraft problems. The 2030 level of development representation of the San Joaquin River Basin does not make any attempt to offer solutions to groundwater overdraft problems. In addition, a dynamic groundwater simulation is not yet developed for the San Joaquin River Valley. Groundwater extraction/ recharge and stream-groundwater interaction are static assumptions and may not accurately reflect a response to simulated actions. These limitations should be considered in the analysis of results.

[i]The CALSIM II model representation for the Stanislaus River does not necessarily represent Reclamation's current or future operational policies. A suitable plan for supporting flows has not been developed for NMFS BO (June 2009) Action 3.1.3.

[j]The actual amount diverted is operated in conjunction with supplies from the Los Vaqueros project. The existing Los Vaqueros storage capacity is 100 TAF. Associated water rights for Delta excess flows are included.

[k]Under Existing Conditions it is assumed that SWP Contractors demand for Table A allocations vary from 3.0 to 4.1 MAF/year. Under the No Action Alternative, it is assumed that SWP Contractors can take delivery of all Table A allocations and Article 21 supplies. Article 56 provisions are assumed and allow for SWP Contractors to manage storage and delivery conditions such that full Table A allocations can be delivered. Article 21 deliveries are limited in wet years under the assumption that demand is decreased in these conditions. Article 21 deliveries for the North Bay Aqueduct are dependent on excess conditions only, all other Article 21 deliveries also require that San Luis Reservoir be at capacity and that Banks Pumping Plant and the California Aqueduct have available capacity to divert from the Delta for direct delivery.

[l]PCWA American River pumping facility upstream of Folsom Lake is included in the Existing Conditions/No Project/No Action Condition. The diversion is assumed to be 35.5 TAF/year.

[m]Footnote removed.

[n]Footnote removed.

[o]Current U.S. Army Corps of Engineers permit for Banks Pumping Plant allows for an average diversion rate of 6,680 cfs in all months. Diversion rate can increase up to 1/3 of the rate of San Joaquin River flow at Vernalis during December 15 – March 15 up to a maximum diversion of 8,500 cfs, if Vernalis flow exceeds 1,000 cfs.

[p]The CCWD Alternate Intake Project, an intake at Victoria Canal, which operates as an alternate Delta diversion for Los Vaqueros Reservoir. This assumption is consistent with the future no-project condition defined by the Los Vaqueros Enlargement study team.

[q]CVPIA (b)(2) fish actions are not dynamically determined in the CALSIM II model, nor is (b)(2) accounting done in the model. Since the USFWS BO and NMFS BO were issued, the Department of the Interior (Interior) has exercised its discretion to use (b)(2) in the delta by accounting some or all of the export reductions required under those biological opinions as (b)(2) actions. It is therefore assumed for modeling purposes that (b)(2) availability for other delta actions will be limited to covering the CVP's Vernalis Adaptive Management Program (VAMP) export reductions. Similarly, since the USFWS BO and NMFS BO were issued, Interior has exercised its discretion to use (b)(2) upstream by accounting some or all of the release augmentations (relative to the hypothetical (b)(2) base case) below Whiskeytown, Nimbus and Goodwin as (b)(2) actions. It is therefore assumed for modeling purposes that (b)(2) availability for other upstream actions will be limited to covering Sacramento releases, in the fall and winter. For modeling purposes, pre-determined time series of minimum instream flow requirements are specified. The time series are based on the August 2008 BA Study 7.0 and Study 8.0 simulations which did include dynamically determined (b)(2) actions.

[r]D-1644 and the Lower Yuba River Accord is assumed to be implemented for the Existing Conditions/No Project/No Action Condition. The Yuba River is not dynamically modeled in CALSIM II. Yuba River hydrology and availability of water acquisitions under the Lower Yuba River Accord are based on modeling performed and provided by the Lower Yuba River Accord EIS/EIR study team.

[s] Under Existing Conditions, the flow components of the proposed American River Flow Management are as required by the NMFS BO (June 4, 2009).

[t]The model operates the Stanislaus River using a 1997 Interim Plan of Operation-like structure, i.e., allocating water for Stockton East Water District and Central San Joaquin Water Conservation District, Vernalis water quality dilution and Vernalis D-1641 flow requirements based on the New Melones Index. Oakdale Irrigation District and South San Joaquin Irrigation District allocations are based on their 1988 agreement, and Ripon DO requirements are represented by a static set of minimum instream flow requirements from June through September. Instream flow requirements for fish below Goodwin are based on NMFS BO Action III.1.2. NMFS BO Action IV.2.1's flow component is not assumed to be in effect.

[u]San Joaquin River Restoration Water Year 2010 Interim Flows Project are assumed, but are *not input into the models; operation not regularly defined at this time.*

[v]In cooperation with Reclamation, NMFS, USFWS, and CDFG, the DWR has developed assumptions for implementation of the USFWS BO (December 15, 2008) and NMFS BO (June 4, 2009) in CALSIM II.

[w]Acquisitions of Component 1 water under the Lower Yuba River Accord, and use of 500 cfs dedicated capacity at Banks Pumping Plant during July – Sep, are assumed to be used to reduce as much of the impact of the April – May Delta export actions on SWP contractors as possible.

[x]Only acquisitions of Lower Yuba River Accord Component 1 water are included.

[y]Shasta Critical years are years in which the forecast full natural inflow into Shasta Lake is expected to be equal to or less than 3.2 million acre-feet within the year.

Notes:
EBMUD = East Bay Municipal Utility District
FERC = Federal Energy Regulatory Commission
FRWP = Freeport Regional Water Project
PCWA = Placer County Water Agency

Table 6A-6
DSM2 Assumptions

In Table 6A-6, the column identified as "No Action Alternative Assumption" represents the "Existing Conditions/No Project/No Action Condition" in the Sites Reservoir EIR/EIS.

	Existing Condition Assumption	No Action Alternative Assumption
Period of simulation	16 years (1976–1991)[a,b]	Same
REGIONAL SUPPLIES		
Boundary flows	Monthly time series from CALSIM II output *(alternatives provide different flows and exports)*[c]	Same
REGIONAL DEMANDS AND CONTRACTS		
Agricultural flows (DICU)	2005 Level, DWR Bulletin 160-98[d]	2020 Level, DWR Bulletin 160-98[d]
TIDAL BOUNDARY		
Martinez stage	15-minute adjusted astronomical tide[a]	Same
WATER QUALITY		
Vernalis EC	Monthly time series from CALSIM II output[e]	Monthly time series from CALSIM II output[e]
Agricultural return EC	Municipal Water Quality Investigation Program analysis	Same
Martinez EC	Monthly net Delta Outflow from CALSIM output & G-model[f]	Monthly net Delta Outflow from CALSIM output & G-model[f]
MORPHOLOGICAL CHANGES		
Mokelumne River	None	None
San Joaquin River	None	None
Middle River	None	None
Dutch Slough Restoration Project	None	None
FACILITIES		
Contra Costa Water District Delta Intakes	Rock Slough Pumping Plant, Old River at Highway 4 Intake	Rock Slough Pumping Plant, Old River at Highway 4 Intake and Alternate Improvement Project Intake on Victoria Canal
South Delta barriers	Temporary Barriers Program	Same
Two Gate Program	None	None
Franks Tract Program	None	None

	Existing Condition Assumption	No Action Alternative Assumption
SPECIFIC PROJECTS		
Water Supply Intake Projects		
Freeport Regional Water Project	None	Monthly output from CALSIM II
Stockton Delta Water Supply Project	None	Monthly output from CALSIM II
Antioch Water Works	Monthly output from CALSIM II	Monthly output from CALSIM II
Sanitary and Agricultural Discharge Projects		
Veale Tract Drainage Relocation	The Veale Tract Water Quality Improvement Project, funded by CALFED, relocates the agricultural drainage outlet was relocated from Rock Slough channel to the southern end of Veale Tract, on Indian Slough[k]	Same
OPERATIONS CRITERIA		
DCC	Monthly time series of number of days open from CALSIM II output	Monthly time series of number of days open from CALSIM II output
Clifton Court Forebay	Priority 3, gate operations synchronized with incoming tide to minimize impacts to low water levels in nearby channels	Same
South Delta barriers	Temporary Barriers Project operated based on San Joaquin River flow time series from CALSIM II output; HORB is assumed only installed[l] September 16 – November 30; Agricultural barriers on OMRs are assumed to be installed starting from May 16 and on Grant Line Canal from June 1; All three barriers are allowed to be operated until November 30; May 16 to May 31 the tidal gates are assumed to be tied open for the barriers on OMRs[m].	Same

[a]A new adjusted astronomical tide for use in DSM2 planning studies has been developed by DWR's Bay Delta Office Modeling Support Branch Delta Modeling Section in cooperation with the Common Assumptions workgroup. This tide is based on a more extensive observed dataset and covers the entire 82-year period of record.

[b]A 16-year period of record is the traditional period for which DSM2 has been used for impacts analysis in many previous projects. The 82-year period of record provides a greater capability to assess stage, velocity and salinity impacts of a project, but it is also necessary for developing water quality parameters for water quality management operations analysis.

[c]Although monthly CALSIM output was used as the DSM2-HYDRO input, the Sacramento and San Joaquin rivers were interpolated to daily values in order to smooth the transition from high to low and low to high flows. DSM2 then uses the daily flow values along with a 15-minute adjusted astronomical tide to simulate effect of the spring and neap tides.

[d]The Delta Island Consumptive Use model is used to calculate diversions and return flows for all Delta islands based on the level of development assumed. The nominal 2005 Delta region hydrology land-use was determined by interpolation between the 1995 and projected 2020 land-use assumptions associated with Bulletin 160-98.

[e]CALSIM II calculates monthly EC for the San Joaquin River, which was then converted to daily EC using the monthly EC and flow for the San Joaquin River. Fixed concentrations of 150, 175, and 125 µmhos/cm were assumed for the Sacramento River, Yolo Bypass, and eastside streams, respectively.

[f]Net Delta outflow based on the CALSIM II flows was used with an updated G-model to calculate Martinez EC. Under changed climate conditions Martinez EC is modified to account for the sea level rise at early (15 cm) and late (45 cm) long-term phases (Year 2060).

[g]Footnote removed.

[h]Footnote removed.

[i]Footnote removed.

[j]Footnote removed.

[k]Information was obtained based on the information from the draft final "Delta Region Drinking Water Quality Management Plan" dated June 2005 prepared under the CALFED Water Quality Program and a presentation by David Briggs at SWRCB public workshop for periodic review. The presentation "Compliance location at Contra Costa Canal at Pumping Plant #1 – Addressing Local Degradation" notes that the Veale Tract drainage relocation project will be operational in June 2005. The DICU drainage currently simulated at node 204 is moved to node 202 in DSM2.

[l]Based on the USFWS Delta Smelt BO Action 5, HORB is assumed to be not installed in April or May; therefore, HORB is only installed in the Fall as shown.

[m]Based on the USFWS Delta Smelt BO Action 5 and the project description provided in the page 119.

Note:

DICU = Delta Island Consumptive Use

6A.5 American River Demands

This section includes the information provided to and agreed to by the lead agencies in the "Bay Delta Conservation Plan EIR/EIS Project – CALSIM II Baselines Models – American River Assumptions," on February 17, 2010.

6A.5.1 Introduction

This memorandum describes the assumptions that are being used for the American River in the Existing Condition and No Action Alternative CALSIM II Baselines models. These assumptions were selected by the DWR and Reclamation management team for the NODOS EIR/EIS in coordination with USFWS and NMFS. The following sections provide an overview of the assumptions, followed by a summary table of the specific diversion related assumptions for each diverter.

6A.5.2 Overview of Assumptions

The following is a summary of the assumptions that will be used to develop the Existing Condition and No Action Alternative models. For specific diversion-related assumptions, see the following section. Note: The column noted as "No Action Alternative" represents "the Existing Conditions/No Project/No Action Condition" in the Sites Reservoir EIR/EIS.

Existing Conditions:

- American River Flow Management is included, as required by the NMFS Biological Opinion (June 2009) Action II.1.
- Water rights and CVP contract demands are assumed at year 2005–2010 levels.
- PCWA Pump Station is included at full demand.
- FRWP is not included.
- Sacramento River Water Reliability Project is not included.
- Sacramento Area Water Forum is not included (dry year "wedge" reductions and mitigation water releases are not included).

No Action Alternative:

- American River Flow Management is included, as required by the NMFS BO (June 2009) Action II.1.
- Water rights and CVP demands are assumed at a full "build-out" condition with CVP contracts at full contract amounts.
- PCWA Pump Station is included at full demand.
- FRWP is included at full demand (EBMUD CVP contracts and Sacramento County Water Agency CVP contract and new appropriative water rights and water acquisitions as modeled in the FRWP EIS/EIR).
- Sacramento River Water Reliability Project is not included.
- Sacramento Area Water Forum is not included (dry year "wedge" reductions and mitigation water releases are not included).

6A.5.3 Summary of American River Demands

The Table 6A-7 summarizes the water rights, CVP contract amounts, and demand amounts for each diverter in the American River system in the Existing Conditions/No Project/No Action Condition. Even though the table shows different assumptions for the Existing Conditions and the No Action Alternative, as noted in Section 6A.2 Assumptions for Existing Conditions/No Project/No Action Condition Model Simulations, the No Action Alternative was used to represent the Existing Conditions/No Project/No Action Condition in the Sites Reservoir Draft EIR/EIS.

Table 6A-7
American River Diversions Assumed in the Existing Conditions and No Action Alternative

In Table 6A-7, the column identified as "No Action Alternative" represents the "Existing Conditions/No Project/No Action Condition" in the Sites Reservoir EIR/EIS.

American River Diversion Amounts Assumed in the Existing and Future Conditions Baselines Models							As of February, 2010
		Existing Conditions (TAF/year)			No Action Alternative (TAF/year)		
	Diversion Location	CVP M&I Contracts (maximum[a])	Water Rights (maximum)	Diversion Limit (maximum capacity)	CVP M&I Contracts (maximum[a])	Water Rights (maximum)	Diversion Limit (maximum capacity)
American River Diversions							
Placer County Water Agency	Auburn Dam Site		35.5	35.5		35.5	35.5
Total		0	35.5	35.5	0	35.5	35.5
Sacramento Suburban Water District[b]	Folsom Reservoir		17	17		17	17
City of Folsom – includes Public Law 101-514		7	27	34	7	27	34
Folsom Prison			2	2		5	5
San Juan Water District (Placer County)			17	17		24	24
San Juan Water District (Sac County) – includes Public Law 101-514		24.2	33	44.2	24.2	33	57.2
El Dorado Irrigation District		7.55	0	7.55	7.55	17	24.55
City of Roseville		32	5	37	32	5	37
Placer County Water Agency		0		0	35		35
El Dorado County – P.L.101-514		15		4	15		15
Total		85.75	101	162.75	120.75	128	248.75
So. Cal WC/Arden Cordova WC	Folsom South Canal		5	5		5	5

American River Diversion Amounts Assumed in the Existing and Future Conditions Baselines Models							As of February, 2010
		Existing Conditions (TAF/year)			No Action Alternative (TAF/year)		
	Diversion Location	CVP M&I Contracts (maximum[a])	Water Rights (maximum)	Diversion Limit (maximum capacity)	CVP M&I Contracts (maximum[a])	Water Rights (maximum)	Diversion Limit (maximum capacity)
California Parks and Recreation	Lower American River	5		1	5		5
SMUD		30	15	20	30	15	45
Canal Losses			1	1		1	1
Total		35	21	27	35	21	56
City of Sacramento[c]			58	58		82.26	82.26
Carmichael Water District			12	12		12	12
Total		0	70	70	0	94.26	94.26
Total American River Diversions		120.75	227.5	295.25	155.75	278.76	434.51
Sacramento River Diversions							
City of Sacramento	Sacramento River Water Reliability Project		0	0		0	0
Placer County Water Agency (Sac Suburban, Roseville and others)			0	0		0	0
Total		0	0	0	0	0	0
City of Sacramento	Sacramento River Pump Station		62.3	62.3		162.74	162.74
Sacramento County Water Agency		15		15	10		10
Total		15	62.3	77.3	10	162.74	172.74
Sacramento County Water Agency	Freeport Regional Water Project	0		0	20		20
Sacramento County Water Agency – P.L. 101-514		0		0	15		15
Sacramento County Water Agency – water rights and acquisitions			0	0		Varies[d]; average 31.2	Varies[d]
East Bay Municipal Utilities District		0		0	133		Varies[e]
Total		0	0	0	168	31.2	35
Total Sacramento River Diversions		0	0	0	168	31.2	35
Total		120.75	227.5	295.25	323.75	309.96	469.51

[a]When the CVP Contract quantity exceeds the quantity of the Diversion Limit minus the Water Right (if any), the diversion modeled is the quantity allocated to the CVP Contract (based on the CVP contract quantity shown times the CVP M&I allocation percentage) plus the Water Right (if any), but with the sum limited to the quantity of the Diversion Limit

[b]Diversion is only allowed if and when Mar-Nov Folsom Unimpaired Inflow (FUI) exceeds 1,600 TAF

[c]When the Hodge single dry year criteria are triggered, Mar-Nov FUI falls below 400 TAF, diversion on the American River is limited to 50 TAF and diversion on the Sacramento River is increased to 164.013 TAF (physical capacity of Sacramento River plant)

[d]SCWA targets 68 TAF of surface water supplies annually. The portion unmet by CVP contract water is assumed to come from two sources:

(1) Delta "excess" water averages 16.5 TAF annually, but varies according to availability. SCWA is assumed to divert excess flow when it is available, and when there is available pumping capacity.

(2) "Other" water-derived from transfers and/or other appropriated water, averaging 14.8 TAF annually but varying according remaining unmet demand.

[e]EBMUD CVP diversions are governed by the Amendatory Contract, stipulating:

(1) 133 TAF maximum diversion in any given year

(2) 165 TAF maximum diversion amount over any 3-year period

(3) Diversions allowed only when EBMUD total storage drops below 500 TAF

(4) 155 cfs maximum diversion rate

6A.6 Refuge Supplies

As part of the CVPIA, the CVP currently provides Firm Level 2 Supplies to State Wildlife Refuges, National Wildlife Refuges (NWR) and private wetlands in the Grassland Resource Conservation District (RCD) identified in the CVPIA. The maximum Firm Level 2 Supply delivered from the CVP, assumed for the Sites Reservoir EIR/EIS modeling, is shown in Table 6A-8. These maximum quantities are delivered to the wildlife refuges in all but Shasta Critical years[2]. In Shasta Critical years, the Firm Level 2 Supply delivered from the CVP is reduced by 25 percent.

Table 6A-8
Wildlife Refuge Firm Level 2 Supplies Delivered from the CVP Assumed for Sites Reservoir EIR/EIS Modeling Purposes

	Existing Conditions/No Project/No Action Condition (TAF)
Sacramento Valley Region	
Colusa NWR	28.8
Delevan NWR	24.0
Sacramento NWR	53.4
Total	106.2
Feather River Region	
Gray Lodge Wildlife Area	41.4
Sutter NWR	25.9
Butte Sink Duck Clubs	15.9
Total	83.2
San Joaquin Region	
China Island – SJBAP	7.0
East Bear Creek NWR	8.9
Freitas – SJBAP	6.3

2 Shasta Critical years are years in which the forecast full natural inflow into Shasta Lake is expected to be equal to or less than 3.2 million acre-feet within the year.

	Existing Conditions/No Project/No Action Condition (TAF)
Grasslands RCD	136.3
Kesterson NWR	10.5
Los Banos WMA	23.6
Mendota WMA	27.6
Merced WMA	0.0
Salt Slough – SJBAP	8.6
San Luis NWR	19.5
Volta WMA	13.0
West Bear Creek NWR	7.5
Total	268.8
Tulare Lake Region	
Kern NWR	11.0
Pixley NWR	1.3
Total	12.3
Grand Total	470.5

Notes:
SJBAP = San Joaquin Basin Action Plan
WMA = Wildlife Management Area

In addition, pursuant to CVPIA, Reclamation is negotiating long-term water supply contracts/agreements for Level 4 Supplies with the CDFW, Grasslands Water District (representing the Grassland RCD), and memoranda of understanding with USFWS.

These contracts/agreements and memoranda of understanding will provide long-term water supplies (up to 25 years) to specified State wildlife areas, private wetlands in the Grassland RCD, and the NWRs identified in the CVPIA. These Level 4 supplies are in addition to the Firm Level 2 Supplies that are provided by the CVP. The maximum Firm Level 4 Supply assumed for the purpose of Sites Reservoir EIR/EIS modeling is shown in Table 6A-9.

Table 6A-9
Wildlife Refuge Level 4 Supplies Delivered Assumed for Sites Reservoir EIR/EIS Modeling Purposes[a]

	Existing Conditions/No Project/No Action Condition (TAF)
Sacramento Valley Region	
Colusa NWR	0.0
Delevan NWR	9.0
Sacramento NWR	3.6
Total	12.6
Feather River Region	
Gray Lodge Wildlife Area	8.6
Sutter NWR	6.5

	Existing Conditions/No Project/No Action Condition (TAF)
Butte Sink Duck Clubs	0.0
Total	15.1
San Joaquin Region	
China Island – SJBAP	3.5
East Bear Creek NWR	4.4
Freitas – SJBAP	0.0
Grasslands RCD	55.1
Kesterson NWR	0.0
Los Banos WMA	10.2
Mendota WMA	2.1
Merced WMA	2.5
Salt Slough – SJBAP	4.3
San Luis NWR	0.0
Volta WMA	3.0
West Bear Creek NWR	3.6
Total	88.6
Tulare Lake Region	
Kern NWR	16.3
Pixley NWR	4.7
Total	21.0
Grand Total	137.4

[a]Reclamation Estimate/Projection (updated 3/4/07).

Level 4 Supplies were not simulated explicitly in the modeling for the Existing Conditions/No Project/No Action Condition, the delivery of water supplies pursuant to the water supply contracts/agreements is assumed to be from a surface water source that is local to the wildlife refuges receiving the supplies and that the modeling of storage or conveyance facilities simulated in the CALSIM II model would be unaffected.

If any of the Project Alternatives (i.e., A, B, C, or D) is implemented, Sites Reservoir would be operated to allocate water supply annually from storage for the wildlife refuges, up to the maximum Level 4 water supply level (Table 6A-9). To manage the rate of drawdown of supplies in Sites Reservoir, if Alternative A or D is implemented, the maximum allocation for wildlife refuges is assumed to be limited to 65 TAF/year. The maximum allocations for Alternatives B, and C are assumed to be limited to 100 TAF/year.

In years in which Sites Reservoir would be used to provide supply, the amount of Level 4 supply pursuant to the long-term water supply contracts/agreements is assumed to be reduced accordingly. Therefore, the wildlife refuges would receive the same amount of supply from Alternatives A, B, C, and D as they would under the Existing Conditions/No Project/No Action Condition. The only change that would occur is that the source for a portion of the Level 4 water supply would change from assumed local sources to Sites Reservoir.

6A.7 Delivery Specifications

Attachment 6A-1 lists the SWP and CVP contract amounts and non-project other water rights assumptions used in the NODOS EIR/EIS No Action Alternative CALSIM II simulations. These specifications are based upon the OCAP BA and have been modified under direction of Reclamation and DWR as described in the preceding sections.

6A.8 USFWS RPA Implementation

The information included in this section is consistent with what was provided to and agreed by the lead agencies in the "*Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies"* on February 10, 2010 (updated May 18, 2010).

6A.8.1 Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies

The USFWS Delta Smelt BO was released on December 15, 2008, in response to the Reclamation's request for formal consultation with the USFWS on the coordinated operations of the CVP and SWP in California.

To develop CALSIM II modeling assumptions for reasonable and RPAs documented in this BO, the DWR led a series of meetings that involved members of fisheries and project agencies. The purpose for establishing this group was to prepare the assumptions and CALSIM II implementations to represent the RPAs in Existing and Future Condition CALSIM II simulations for future planning studies.

This memorandum summarizes the approach that resulted from these meetings and the modeling assumptions that were laid out by the group. The scope of this memorandum is limited to the December 15, 2008 BO. Unless otherwise indicated, all descriptive information of the RPAs is taken from Appendix B of the BO.

Table 6A-10 lists the participants that contributed to the meetings and information summarized in this document.

The RPAs in the USFWS BO are based on physical and biological phenomena that do not lend themselves to simulations using a monthly time step. Much scientific and modeling judgment has been employed to represent the implementation of the RPAs. The group believes the logic put into CALSIM II represents the RPAs as best as possible at this time, given the scientific understanding of environmental factors enumerated in the BO and the limited historical data for some of these factors.

Table 6A-10
Meeting Participants

Aaron Miller/DWR Steve Ford/DWR Randi Field/Reclamation Gene Lee/Reclamation Lenny Grimaldo/Reclamation	Derek Hilts/USFWS Steve Detwiler/USFWS Matt Nobriga/CDFG Jim White/CDFG Craig Anderson/NMFS
Parviz Nader-Tehrani/DWR Erik Reyes/DWR Sean Sou/DWR	Robert Leaf/CH2M HILL Derya Sumer/CH2M HILL

Notes:
NMFS = National Marine Fisheries Service

The simulated OMR flow conditions and CVP and SWP Delta export operations, resulting from these assumptions, are believed to be a reasonable representation of conditions expected to prevail under the RPAs over large spans of years (refer to CALSIM II modeling results for more details on simulated operations). Actual OMR flow conditions and Delta export operations will differ from simulated operations for numerous reasons, including having near real-time knowledge and/or estimates of turbidity, temperature, and fish spatial distribution that are unavailable for use in CALSIM II over a long period of record. Because these factors and others are believed to be critical for smelt entrainment risk management, the USFWS adopted an adaptive process in defining the RPAs. Given the relatively generalized representation of the RPAs, assumed for CALSIM II modeling, much caution is required when interpreting outputs from the model.

6A.8.2 Action 1: Adult Delta Smelt Migration and Entrainment (RPA Component 1, Action 1 – First Flush)

6A.8.2.1 Action 1 Summary

Objective: A fixed duration action to protect pre-spawning adult delta smelt from entrainment during the first flush, and to provide advantageous hydrodynamic conditions early in the migration period.

Action: Limit exports so that the average daily Combined OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent).

Timing:

Part A: December 1 to December 20 – Based upon an examination of turbidity data from Prisoner's Point, Holland Cut, and Victoria Canal and salvage data from CVP/SWP (see below), and other parameters important to the protection of delta smelt including, but not limited to, preceding conditions of X2, the Fall Midwater Trawl Survey, and river flows; the Smelt Working Group (SWG) may recommend a start date to the USWFS. The USFWS will make the final determination.

Part B: After December 20 – The action will begin if the 3-day average turbidity at Prisoner's Point, Holland Cut, and Victoria Canal exceeds 12 nephelometric turbidity units (NTU). However, the SWG can recommend a delayed start or interruption based on other conditions such as Delta inflow that may affect vulnerability to entrainment.

Triggers (Part B):

Turbidity: Three-day average of 12 NTU or greater at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal.

OR

Salvage: Three days of delta smelt salvage after December 20 at either facility or cumulative daily salvage count that is above a risk threshold based upon the "daily salvage index" approach reflected in a daily salvage index value ≥ 0.5 (daily delta smelt salvage > one-half prior year Fall Midwater Trawl Survey index value).

The window for triggering Action 1 concludes when either off-ramp condition described below is met. These off-ramp conditions may occur without Action 1 ever being triggered. If this occurs, then Action 3 is triggered, unless the USFWS concludes on the basis of the totality of available information that Action 2 should be implemented instead.

Off-ramps:

Temperature: Water temperature reaches 12 degrees Celsius (°C) based on a three station daily mean at the temperature stations: Mossdale, Antioch, and Rio Vista

OR

Biological: Onset of spawning (presence of spent females in the Spring Kodiak Trawl Survey [SKT] or at Banks or Jones).

6A.8.2.2 Action 1 Assumptions for CALSIM II Modeling Purposes

An approach was selected based on hydrologic and assumed turbidity conditions. Under this general assumption, Part A of the action was never assumed because, on the basis of historical salvage data, it was considered unlikely or rarely to occur. Part B of the action was assumed to occur if triggered by turbidity conditions. This approach was believed to tend to a more conservative interpretation of the frequency, timing, and extent of this action. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent of the monthly criteria).

Timing: If turbidity-trigger conditions first occur in December, then the action starts on December 21; if turbidity-trigger conditions first occur in January, then the action starts on January 1; if turbidity-trigger conditions first occur in February, then the action starts on February 1; and if turbidity-trigger conditions first occur in March, then the action starts on March 1. It is assumed that once the action is triggered, it continues for 14 days.

Triggers: Only an assumed turbidity trigger that is based on hydrologic outputs was considered. A surrogate salvage trigger or indicator was not included because there was no way to model it.

Turbidity: If the monthly average unimpaired Sacramento River Index (four-river index: sum of Sacramento, Yuba, Feather, and American Rivers) exceeds 20,000 cfs, then it is assumed that an event, in which the 3-day average turbidity at Hood exceeds 12 NTU, has occurred within the month. It is assumed that an event at Sacramento River is a reasonable indicator of this condition occurring, within the month, at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal.

A chart showing the relationship between turbidity at Hood (number of days with turbidity is greater than 12 NTU) and Sacramento River Index (sum of monthly flow at four stations on the Sacramento, Feather, Yuba and American Rivers, from 2003 to 2006) is shown on Figure 6A-1. For months when average Sacramento River Index is between 20,000 cfs and 25,000 cfs a transition is observed in number of days with Hood turbidity greater than 12 NTU. For months when average Sacramento River Index is above 25,000 cfs, Hood turbidity was always greater than 12 NTU for as many as 5 days or more within the month in which the flow occurred. For a conservative approach, 20,000 cfs is used as the threshold value.

Salvage: It is assumed that salvage would occur when first flush occurs.

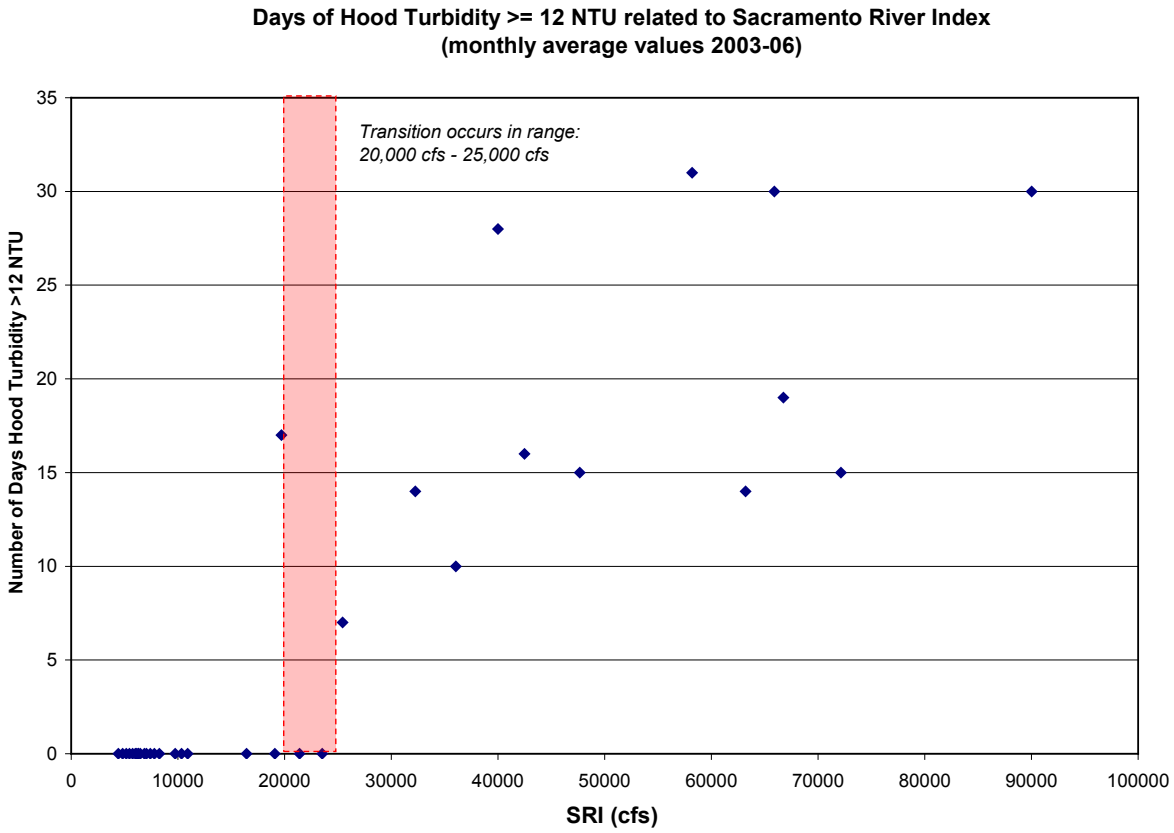

Figure 6A-1. Relationship between Turbidity at Hood and Sacramento River Index

Off-ramps: Only temperature-based off-ramping is considered. A surrogate biological off-ramp indicator was not included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought for use as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (see Figure 6A-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, estimated daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CALSIM. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 6A-2.

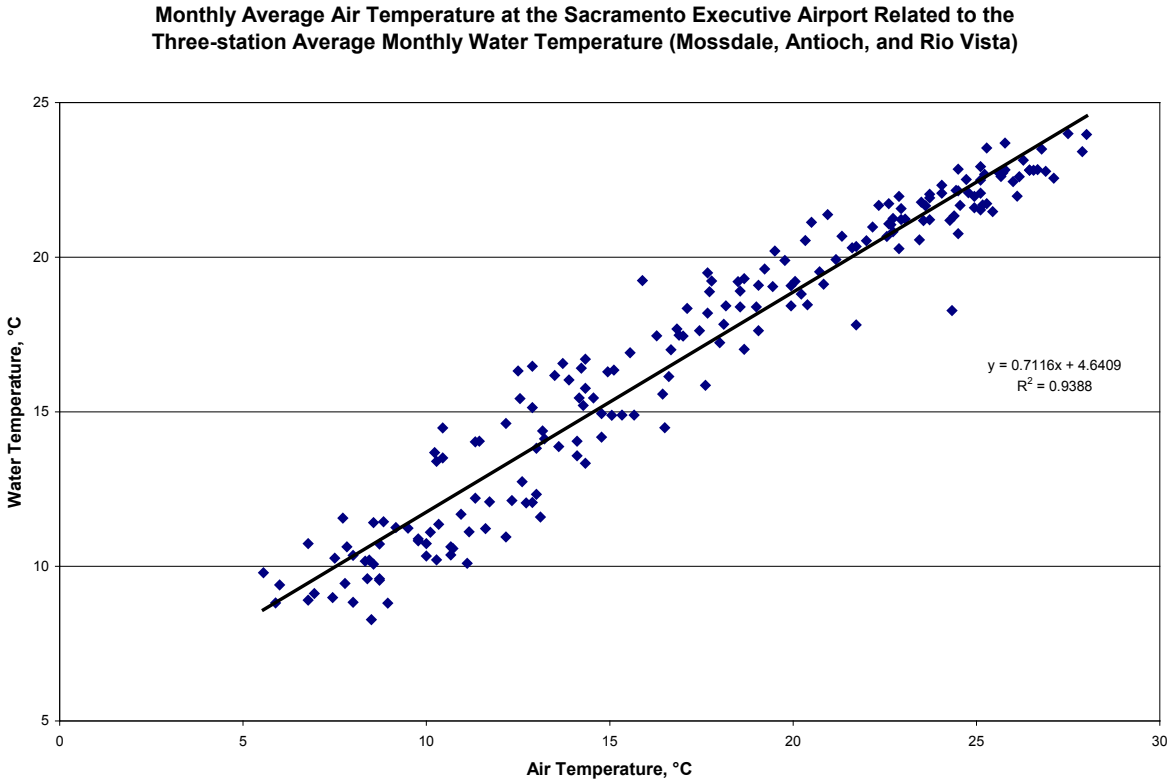

Figure 6A-2. Relationship between Monthly Average Air Temperature at the Sacramento Executive Airport and the Three-station Average Monthly Water Temperature

Other Modeling Considerations:

In the month of December in which Action 1 does not begin until December 21, for monthly analysis, a background OMR flow must be assumed for the purpose of calculating a day-weighted average for implementing a partial-month action condition. When necessary, the background OMR flow for December was assumed to be -8,000 cfs.

For the additional condition to meet a 5-day running average no more negative than -2,500 cfs (within 25 percent), Paul Hutton's equation (Hutton, 2009) is used. Hutton concluded that with stringent OMR standards (1,250 to 2,500 cfs), the 5-day average would control more frequently than the 14-day average, but it is less likely to control at higher flows. Therefore, the CALSIM II implementation includes both a 14-day (approximately monthly average) and a 5-day average flow criteria based on Hutton's methodology (see Attachment 6A-2).

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 1.

December 1 to December 20 for initiating Action 1 is not considered because seasonal peaks of delta smelt salvage are rare prior to December 20. Adult delta smelt spawning migrations often begin following large precipitation events that happen after mid-December.

Salvage of adult delta smelt often corresponds with increases in turbidity and exports. On the basis of the above discussion and Figure 6A-1, Sacramento River Index greater than 25,000 cfs is assumed to be an

indicator of turbidity trigger being reached at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal. Most sediment enters the Delta from the Sacramento River during flow pulses; therefore, a flow indicator based on only Sacramento River flow is used.

The 12°C threshold for the off-ramp criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

Results: Using these assumptions, in a typical CALSIM II 82-year simulation (1922 through 2003 hydrologic conditions), Action 1 will occur 29 times in the December 21 to January 3 period, 14 times in the January 1 to January 14 period, 13 times in the February 1 to February 14 period, and 17 times in the March 1 to March 14 period. In 3 of these 17 occurrences (1934, 1991, and 2001), Action 3 is triggered before Action 1 and, therefore, Action 1 is bypassed. Action 1 is not triggered in 9 of the 82 years (1924, 1929, 1931, 1955, 1964, 1976, 1977, 1985, and 1994), typically critically dry years. Refer to CALSIM II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest.

6A.8.3 Action 2: Adult Delta Smelt Migration and Entrainment (RPA Component 1, Action 2)

6A.8.3.1 Action 2 Summary

Objective: An action implemented using an adaptive process to tailor protection to changing environmental conditions after Action 1. As in Action 1, the intent is to protect pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions.

Action: The range of net daily OMR flows will be no more negative than -1,250 to -5,000 cfs. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the USFWS SWG from the onset of Action 2 through its termination (see Adaptive Process description in the BO). The SWG would provide weekly recommendations based upon review of the sampling data, from real-time salvage data at the CVP and SWP, and utilizing most up-to-date technological expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The USFWS will make the final determination.

Timing: Beginning immediately after Action 1. Before this date (in time for operators to implement the flow requirement) the SWG will recommend specific requirement OMR flows based on salvage and on physical and biological data on an ongoing basis. If Action 1 is not implemented, the SWG may recommend a start date for the implementation of Action 2 to protect adult delta smelt.

Suspension of Action:

Flow: OMR flow requirements do not apply whenever a 3-day flow average is greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and 10,000 cfs in San Joaquin River at Vernalis. Once such flows have abated, the OMR flow requirements of the Action are again in place.

Off-ramps:

Temperature: Water temperature reaches 12°C based on a three-station daily average at the temperature stations: Rio Vista, Antioch, and Mossdale.

OR

Biological: Onset of spawning (presence of a spent female in SKT or at either facility).

6A.8.3.2 Action 2 Assumptions for CALSIM II Modeling Purposes

An approach was selected based on the occurrence of Action 1 and X2 salinity conditions. This approach selects from between two OMR flow tiers depending on the previous month's X2 position, and is never more constraining than an OMR criterion of -3,500 cfs. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -3,500 or -5,000 cfs depending on the previous month's ending X2 location (-3,500 cfs if X2 is east of Roe Island, or -5,000 cfs if X2 is west of Roe Island), with a 5-day running average within 25 percent of the monthly criteria (no more negative than -4,375 cfs if X2 is east of Roe Island, or -6,250 cfs if X2 is west of Roe Island).

Timing: Begins immediately after Action 1 and continues until initiation of Action 3.

In a typical CALSIM II 82-year simulation, Action 1 was not triggered in 9 of the 82 years. In these conditions, it is assumed that OMR flow should be maintained no more negative than -5,000 cfs.

Suspension of Action: A flow peaking analysis (Hutton, 2009) is used to determine the likelihood of a 3-day flow average greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and a 3-day flow average greater than or equal to 10,000 cfs in San Joaquin River at Vernalis occurring within the month. It is assumed that when the likelihood of these conditions occurring exceeds 50 percent, Action 2 is suspended for the full month, and OMR flow requirements do not apply. The likelihood of these conditions occurring is evaluated each month, and Action 2 is suspended for 1 month at a time when both of these conditions occur.

The equations for likelihood (frequency of occurrence) are as follows:

Frequency of Rio Vista 3-day flow average > 90,000 cfs:

0 percent when Freeport monthly flow < 50,000 cfs, OR

(0.00289 x Freeport monthly flow – 146) percent when 50,000 cfs ≤ Freeport plus Yolo Bypass monthly flow ≤ 85,000 cfs, OR

100 percent when Freeport monthly flow >85,000 cfs

Frequency of Vernalis 3-day flow average > 10,000 cfs:

0 percent when Vernalis monthly flow < 6,000 cfs, OR

(0.00901 x Vernalis monthly flow – 49) percent when 6,000 cfs ≤ Vernalis monthly flow ≤ 16,000 cfs, OR

100 percent when Vernalis monthly flow >16,000 cfs

Frequency of Rio Vista 3-day flow average > 90,000 cfs equals 50 percent when Freeport plus Yolo Bypass monthly flow is 67,820 cfs and the frequency of Vernalis 3-day flow average > 10,000 cfs equals 50 percent Vernalis monthly flow is 10,988 cfs. Therefore, these two flow values are used as thresholds in the model.

Off-ramps: Only temperature-based off-ramping is considered. A surrogate biological off-ramp indicator was not included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought for use as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (Figure 6A-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CALSIM. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 6A-2.

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 2.

Action 2 requirements are based on X2 location that is dependent on the Delta outflow. If outflows are very high, fewer delta smelt will spawn east of Sherman Lake; therefore, the need for OMR restrictions is lessened.

In the case of Action 1 not being triggered, CDFG suggested OMR > -5,000 cfs, following the actual implementation of the BO in winter 2009, because some adult delta smelt might move into the Central Delta without a turbidity event.

Action 2 is suspended when the likelihood of a 3-day flow average greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and a 3-day flow average greater than or equal to 10,000 cfs in San Joaquin River at Vernalis occurring concurrently within the month exceeds 50 percent, because at extreme high flows the majority of adult delta smelt will be distributed downstream of the Delta, and entrainment concerns will be very low.

The 12°C threshold for the off-ramp criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

Results: Using these assumptions, in a typical CALSIM II 82-year simulation (1922 through 2003 hydrologic conditions), Action 1, and, therefore, Action 2, does not occur in 11 of the 82 years (1924, 1929, 1931, 1934, 1955, 1964, 1976, 1977, 1985, 1991, 1994, and 2001), typically critically dry years. The criteria for suspension of OMR minimum flow requirements, described above, results in potential suspension of Action 2 (if Action 2 is active) 6 times in January, 11 times in February, 6 times in March (however, Action 2 was not active in 3 of these 6 times), and 2 times in April. The result is that Action 2 is in effect 37 times in January (with OMR at -3,500 cfs 29 times, and at -5,000 cfs 8 times), 43 times in February (with OMR at -3,500 cfs 25 times, and at -5,000 cfs 18 times), 31 times in March (with OMR at -3,500 cfs 14 times, and at -5,000 cfs 17 times), and 80 times in April (with OMR at -3,500 cfs 46 times, and at -5,000 cfs 34 times). The frequency each month is a cumulative result of the action being triggered in the current or prior months. Refer to CALSIM II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest.

6A.8.4 Action 3: Entrainment Protection of Larval and Juvenile Delta Smelt (RPA Component 2)

6A.8.4.1 Action 3 Summary

Objective: Minimize the number of larval delta smelt entrained at the facilities by managing the hydrodynamics in the Central Delta flow levels pumping rates spanning a time sufficient for protection of larval delta smelt, e.g., by using a Vernalis Adaptive Management Program (VAMP)-like action. Because protective OMR flow requirements vary over time (especially between years), the action is adaptive and flexible within appropriate constraints.

Action: Net daily OMR flow will be no more negative than -1,250 to -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the SWG from the onset of Action 3 through its termination (see Adaptive Process in Introduction). The SWG would provide these recommendations based upon weekly review of sampling data, from real-time salvage data at the CVP/SWP, and expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The USFWS will make the final determination.

Timing: Initiate the action after reaching the triggers below, which are indicative of spawning activity and the probable presence of larval delta smelt in the South and Central Delta. Based upon daily salvage data, the SWG may recommend an earlier start to Action 3. The USFWS will make the final determination.

Triggers:

Temperature: When temperature reaches 12°C based on a three-station average at the temperature stations: Mossdale, Antioch, and Rio Vista.

OR

Biological: Onset of spawning (presence of spent females in SKT or at either facility).

Off-ramps:

Temporal: June 30;

OR

Temperature: Water temperature reaches a daily average of 25°C for 3 consecutive days at Clifton Court Forebay.

6A.8.4.2 Action 3 Assumptions for CALSIM II Modeling Purposes

An approach was selected based on assumed temperature and X2 salinity conditions. This approach selects from among three OMR flow tiers depending on the previous month's X2 position and ranges from an OMR criteria of -1,250 to -5,000 cfs. Because of to the potential low export conditions that could occur at an OMR criterion of -1,250 cfs, a criterion for minimum exports for health and safety is also assumed. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -1,250, -3,500, or -5,000 cfs, depending on the previous month's ending X2 location (-1,250 cfs if X2 is east of Chipps

Island, -5,000 cfs if X2 is west of Roe Island, or -3,500 cfs if X2 is between Chipps and Roe Island, inclusively), with a 5-day running average within 25 percent of the monthly criteria (no more negative than -1,562 cfs if X2 is east of Chipps Island, -6,250 cfs if X2 is west of Roe Island, or -4,375 cfs if X2 is between Chipps and Roe Island). The more constraining of this OMR requirement or the VAMP requirement will be selected during the VAMP period (April 15 to May 15). Additionally, in the case of the month of June, the OMR criterion from May is maintained through June (it is assumed that June OMR should not be more constraining than May).

Timing: Begins immediately upon temperature trigger conditions and continues until off-ramp conditions are met.

Triggers: Only temperature trigger conditions are considered. A surrogate biological trigger was included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought to be used as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (Figure 6A-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, estimated daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CALSIM. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 6A-2.

Biological: Onset of spawning is assumed to occur no later than May 30.

Clarification Note: This text previously read "Onset of spawning is assumed to occur no later than April 30," where the CALSIM II lookup table has May 30 as the date. Based on RPA team discussions in August 2009, it was agreed upon that onset of spawning could not be modeled in CALSIM. This trigger was actually coded as a placeholder in case this trigger was to be used in the future and the date was selected purposefully in a way that it wouldn't affect modeling results. The temperature trigger for Action 3 does occur before end of April. Therefore, it does not matter whether the document is corrected to read May 30 or the model lookup table is changed to April 30.

Off-ramps:

Temporal: It is assumed that the ending date of the action would be no later than June 30.

OR

Temperature: Only 17 years of data are available for Clifton Court water temperature. A similar approach as used in the temperature trigger was considered. However, because 3 consecutive days of water temperature greater than or equal to 25°C is required, a correlation between air temperature and water temperature did not work well for this off-ramp criterion. Out of the 17 recorded years, in one year the criterion was triggered in May (May 31), and in 3 years it was triggered in June (June 3, 21, and 27). In all other years, it was observed in July or later. With only four data points before July, it was not possible to generate a rule based on statistics. Therefore, temporal off-ramp criterion (June 30) is used for all years.

Health and Safety: In CALSIM II, a minimum monthly Delta export criterion of 300 cfs for SWP and 600 cfs (or 800 cfs depending on Shasta storage) for CVP is assumed. This assumption is suitable for dry-year conditions when allocations are low and storage releases are limited; however, minimum monthly exports need to be made for protection of public health and safety (health and safety deliveries upstream of San Luis Reservoir).

In consideration of the severe export restrictions associated with the OMR criteria established in the RPAs, an additional set of health and safety criterion is assumed. These export restrictions could lead to a situation in which supplies are available and allocated; however, exports are curtailed forcing San Luis to have an accelerated drawdown rate. For dam safety at San Luis Reservoir, 2 feet per day is the maximum acceptable drawdown rate. Drawdown occurs faster in summer months and peaks in June when the agricultural demands increase. To avoid rapid drawdown in San Luis Reservoir, a relaxation of OMR is allowed so that exports can be maintained at 1,500 cfs in all months if needed.

This modeling approach may not fit the real-life circumstances. In summer months, especially in June, the assumed 1,500 cfs for health and safety may not be sufficient to keep San Luis drawdown below a safe 2 feet per day; and under such circumstances the projects would be required to increase pumping to maintain dam safety.

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 3.

The geographic distribution of larval and juvenile delta smelt is tightly linked to X2 (or Delta outflow). Therefore, the percentage of the population likely to be found east of Sherman Lake is also influenced by the location of X2. The X2-based OMR criteria were intended to model an expected management response to the general increase in delta smelt's risk of entrainment as a function of increasing X2.

The 12°C threshold for the trigger criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

The annual salvage "season" for delta smelt typically ends as South Delta water temperatures warm to lethal levels during summer. This usually occurs in late June or early July. The laboratory-derived upper lethal temperature for delta smelt is 25.4°C.

Results: Action 3 occurs 30 times in February (with OMR at -1,250 cfs 9 times, at -3,500 cfs 11 times, and at -5,000 cfs 10 times), 76 times in March (with OMR at -1,250 cfs 15 times, at -3,500 cfs 27 times, and at -5,000 cfs 34 times), all times (82) in April (with OMR at -1,250 cfs 17 times, at -3,500 cfs 29 times, and at -5,000 cfs 35 times), all times (82) in May (with OMR at -1,250 cfs 19 times, at -3,500 cfs 37 times, and at -5,000 cfs 26 times), and 70 times in June (with OMR at -1,250 cfs 7 times, at -3,500 cfs 37 times, and at -5,000 cfs 26 times). Refer to CALSIM II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest. (Note: This information is based on the August 2009 version of the model and documents the development process; more recent versions of the model may have different results.)

6A.8.5 Action 4: Estuarine Habitat During Fall (RPA Component 3)

6A.8.5.1 Action 4 Summary

Objective: Improve fall habitat for delta smelt by managing of X2 through increasing Delta outflow during fall when the preceding water year was wetter than normal. This will help return ecological

conditions of the estuary to that which occurred in the late 1990s when smelt populations were much larger. Flows provided by this action are expected to provide direct and indirect benefits to delta smelt. Both the direct and indirect benefits to delta smelt are considered equally important to minimize adverse effects.

Action: Subject to adaptive management as described below, provide sufficient Delta outflow to maintain average X2 for September and October no greater (more eastward) than 74 km in the fall following wet years and 81 km in the fall following above normal years. The monthly average X2 position is to be maintained at or seaward of these locations for each individual month and not averaged over the 2-month period. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall X2 target. The action will be evaluated and may be modified or terminated as determined by the USFWS.

Timing:

September 1 to November 30.

Triggers:

Wet and above normal water-year type classification from the 1995 WQCP that is used to implement D-1641.

6A.8.5.2 Action 4 Assumptions for CALSIM II Modeling Purposes

Model is modified to increase Delta outflow to meet monthly average X2 requirements for September and October and subsequent November reservoir release actions in Wet and Above Normal years. No off-ramps are considered for reservoir release capacity constraints. Delta exports may or may not be reduced as part of reservoir operations to meet this action. The Action is summarized in Table 6A-11.

Table 6A-11
Summary of Action 4 Implementation in CALSIM II

Fall Months Following Wet or Above Normal Years	Action Implementation
September	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
October	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
November	Add reservoir releases up to natural inflow as needed to continue to meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)

Rationale: Action 4 requirements are based on determining X2 location. Adjustment and retraining of the ANN was also completed to address numerical sensitivity concerns.

Results: There are 38 September and 37 October months that the Action is triggered over the 82-year simulation period.

6A.8.6 Action 5: Temporary Spring Head of Old River Barrier and the Temporary Barrier Project (RPA Component 2)

6A.8.6.1 Action 5 Summary

Objective: To minimize entrainment of larval and juvenile delta smelt at Banks and Jones or from being transported into the South and Central Delta, where they could later become entrained.

Action: Do not install the Spring HORB if delta smelt entrainment is a concern. If installation of the HORB is not allowed, the agricultural barriers would be installed as described in the Project Description. If installation of the HORB is allowed, the Temporary Barrier Project (TBP) flap gates would be tied in the open position until May 15.

Timing: The timing of the action would vary depending on the conditions. The normal installation of the spring temporary HORB and the TBP is in April.

Triggers: For delta smelt, installation of the HORB will only occur when particle tracking modeling results show that entrainment levels of delta smelt will not increase beyond 1 percent at Station 815 as a result of installing the HORB.

Off-ramps: If Action 3 ends or May 15, whichever comes first.

6A.8.6.2 Action 5 Assumptions for CALSIM II and DSM2 Modeling Purposes

The South Delta Improvement Program Stage 1 is not included in the Existing and Future Condition assumptions being used for CALSIM II and DSM2 baselines. The TBP is assumed instead. The TBP specifies that HORB be installed and operated during April 1 through May 31 and September 16 through November 30. In response to the USFWS BO, Action 5, the HORB is assumed to not be installed during April 1 through May 31.

6A.9 NMFS RPA Implementation

The information included in this section is consistent with what was provided to and agreed by the lead agencies in the, "*Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies,"* on February 10, 2010.

6A.9.1 Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies

The NMFS BO on the Long-term Operations of the Central Valley Project and State Water Project was released on June 4, 2009.

To develop CALSIM II modeling assumptions to represent the operations-related RPA alternatives required by this BO, the DWR led a series of meetings that involved members of fisheries and project agencies. The purpose for establishing this group was to prepare the assumptions and CALSIM II implementations to represent the RPAs in both Existing- and Future-Condition CALSIM II simulations for future planning studies.

This memorandum summarizes the approach that resulted from these meetings and the modeling assumptions that were laid out by the group. The scope of this memorandum is limited to the June 4, 2009 BO. All descriptive information of the RPAs is taken from the BO.

Table 6A-12 lists the participants that contributed to the meetings and information summarized in this document.

The RPAs in NMFS's BO are based on physical and biological processes that do not lend themselves to simulations using a monthly time step. Much scientific and modeling judgment has been employed to represent the implementation of the RPAs. The group believes the logic put into CALSIM II represents the RPAs as best as possible at this time, given the scientific understanding of environmental factors enumerated in the BO and the limited historical data for some of these factors.

Given the relatively generalized representation of the RPAs assumed for CALSIM II modeling, much caution is required when interpreting outputs from the model.

Table 6A-12
Meeting Participants

Aaron Miller/DWR Randi Field/Reclamation Lenny Grimaldo/Reclamation Henry Wong/Reclamation	Derek Hilts/USFWS Roger Guinee/USFWS Matt Nobriga/CDFG Bruce Oppenheim/NMFS
Parviz Nader-Tehrani/DWR Erik Reyes/DWR Sean Sou/DWR Paul A. Marshall/DWR Ming-Yen Tu/DWR Xiaochun Wang/DWR	Robert Leaf/CH2M HILL Derya Sumer/CH2M HILL

Notes:
NMFS = National Marine Fisheries Service
USFWS = U.S. Fish and Wildlife Service

6A.9.1.1 Action Suite 1.1 Clear Creek

Suite Objective: The RPA actions described below were developed based on a careful review of past flow studies, current operations, and future climate change scenarios. These actions are necessary to address adverse project effects on flow and water temperature that reduce the viability of spring-run and Central Valley steelhead in Clear Creek.

Action 1.1.1 Spring Attraction Flows

Objective: Encourage spring-run movement to upstream Clear Creek habitat for spawning.

Action: Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least 3 days for each pulse, to attract adult spring-run holding in the Sacramento River main stem.

Action 1.1.1 Assumptions for CALSIM II Modeling Purposes

Action: Model is modified to meet 600 cfs for 3 days twice in May. In the CALSIM II analysis, flows sufficient to increase flow up to 600 cfs for a total of 6 days are added to the flows that would have otherwise occurred in Clear Creek.

Rationale: CALSIM II is a monthly model. The monthly flow in Clear Creek is an underestimate of the actual flows that would occur subject to daily operational constraints at Whiskeytown Reservoir. The additional flow to meet 600 cfs for a total of 6 days was added to the monthly average flow modeled.

Action 1.1.5. Thermal Stress Reduction

Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.

Action: Reclamation shall manage Whiskeytown releases to meet a daily water temperature of: 1) 60 degrees Fahrenheit (°F) at the Igo gage from June 1 through September 15; and 2) 56°F at the Igo gage from September 15 to October 31.

Action 1.1.5 Assumptions for CALSIM II Modeling Purposes

Action: It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: A temperature model of Whiskeytown Reservoir has been developed by Reclamation. Further analysis using this or other temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model.

6A.9.1.2 Action Suite 1.2 Shasta Operations

Objectives: To address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:

1. Ensure a sufficient cold-water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years, without sacrificing the potential for cold-water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the population to temperature effects attributable to changes in Trinity River ROD operations, projected climate change hydrology, and increased water demands in the Sacramento River system.
2. Ensure suitable spring-run temperature regimes, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Residents.
3. Establish a second population of winter-run in Battle Creek as soon as possible, to partially compensate for unavoidable project-related effects on the one remaining population.
4. Restore passage at Shasta Reservoir with experimental reintroductions of winter-run to the upper Sacramento and/or McCloud rivers, to partially compensate for unavoidable project-related effects on the remaining population.

Action 1.2.1 Performance Measures

Objective: To establish and operate to a set of performance measures for temperature compliance points and End-of-September (EOS) carryover storage, enabling Reclamation and NMFS to assess the effectiveness of this suite of actions over time. Performance measures will help to ensure that the beneficial variability of the system from changes in hydrology will be measured and maintained.

Action: To ensure a sufficient cold-water pool to provide suitable temperatures, long-term performance measures for temperature compliance points and EOS carryover storage at Shasta Reservoir shall be attained. Performance measures for EOS carryover storage at Shasta Reservoir are as follows:

- 87 percent of years: Minimum EOS storage of 2.2 MAF

- 82 percent of years: Minimum EOS storage of 2.2 MAF and end-of-April storage of 3.8 MAF in following year (to maintain potential to meet Balls Ferry compliance point)
- 40 percent of years: Minimum EOS storage 3.2 MAF (to maintain potential to meet Jelly's Ferry compliance point in following year)

Performance measures (measured as a 10-year running average) for temperature compliance points during summer season are:

- Meet Clear Creek Compliance point 95 percent of time
- Meet Balls Ferry Compliance point 85 percent of time
- Meet Jelly's Ferry Compliance point 40 percent of time
- Meet Bend Bridge Compliance point 15 percent of time

Action 1.2.1 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. System performance will be assessed and evaluated through post-processing of various model results.

Rationale: Given that the performance criteria are based on the CALSIM II modeling data used in preparation of the BA, the system performance after application of the RPAs should be similar as a percentage of years that the end-of-April storage and temperature compliance requirements are met over the simulation period. Post-processing of modeling results will be compared to various new operating scenarios as needed to evaluate performance criteria and appropriateness of the rules developed.

Action 1.2.2 November through February Keswick Release Schedule (Fall Actions)

Objective: Minimize impacts to listed species and naturally spawning non-listed fall-run from high water temperatures by implementing standard procedures for release of cold water from Shasta Reservoir.

Action: Depending on EOS carryover storage and hydrology, Reclamation shall develop and implement a Keswick release schedule, and reduce deliveries and exports as needed to achieve performance measures.

Action 1.2.2 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. Keswick flows based on operation of 3406(b)(2) releases in OCAP Study 7.1 (for Existing) and Study 8 (for Future) are used in CALSIM II. These flows will be reviewed for appropriateness under this action. A post-process based evaluation similar to what has been explained in Action 1.2.1 will be conducted.

Rationale: Performance measures are set as percentage of years that the end-of-September and temperature compliance requirements are met over the simulation period. Post-processing of modeling results will be compared to various new operating scenarios as needed to evaluate performance criteria and appropriateness of the rules developed.

Action 1.2.3 February Forecast; March – May 14 Keswick Release Schedule (Spring Actions)

Objective: To conserve water in Shasta Reservoir in the spring to provide sufficient water to reduce adverse effects of high water temperature in the summer months for winter-run, without sacrificing carryover storage in the fall.

Actions: 1) Reclamation shall make its February forecast of deliverable water based on an estimate of precipitation and runoff within the Sacramento River basin at least as conservative as the 90 percent probability of exceedance. Subsequent updates of water delivery commitments must be based on monthly forecasts at least as conservative as the 90 percent probability of exceedance, 2) Reclamation shall make releases to maintain a temperature compliance point not in excess of 56 degrees between Balls Ferry and Bend Bridge from April 15 through May 15.

Action 1.2.3 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: Temperature models of Shasta Lake and the Sacramento River have been developed by Reclamation. This modeling reflects current facilities for temperature controlled releases. Further analysis using this or another temperature model can further verify that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably at each of the compliance points. In the future, it may be that adjusted flow schedules may need to be developed based on development of temperature model runs in conjunction with CALSIM II modeled operations.

Action 1.2.4 May 15 through October Keswick Release Schedule (Summer Action)

Objective: To manage the cold-water storage within Shasta Reservoir and make cold-water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run, spring-run, Central Valley steelhead, and Southern DPS of green sturgeon in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts. To the extent feasible, manage for suitable temperatures for naturally spawning fall-run.

Action: Reclamation shall manage operations to achieve daily average water temperatures in the Sacramento River between Keswick Dam and Bend Bridge as follows:

1) Not in excess of 56°F at compliance locations between Balls Ferry and Bend Bridge from May 15 through September 30 for protection of winter-run, and not in excess of 56°F at the same compliance locations between Balls Ferry and Bend Bridge from October 1 through October 31 for protection of mainstem spring run, whenever possible.

2) Reclamation shall operate to a final Temperature Management Plan starting May 15 and ending October 31.

Action 1.2.4 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flows included in model. During the detailed effects analysis, temperature modeling and post-processing will be used to verify temperatures are met at the compliance points. In the long-term approach, for a complete interpretation of the action, development of temperature model runs is needed to develop flow schedules if needed for implementation into CALSIM II.

Rationale: Temperature models of Shasta Lake and the Sacramento River have been developed by Reclamation. This modeling reflects current facilities for temperature controlled releases. Further analysis using this or another temperature model is required to verify the statement that temperature operations can

perform reasonably well with flows included in model and temperatures are met reliably at each of the compliance points. It may be that alternative flow schedules may need to be developed based on development of temperature model runs in conjunction with CALSIM II modeled operations.

6A.9.1.3 Action Suite 1.3 RBDD Operations

Objectives: Reduce mortality and delay of adult and juvenile migration of winter-run, spring-run, Central Valley steelhead, and Southern DPS of green sturgeon caused by the presence of the diversion dam and the configuration of the operable gates. Reduce adverse modification of the passage element of critical habitat for these species. Provide unimpeded upstream and downstream fish passage in the long term by raising the gates year-round, and minimize adverse effects of continuing dam operations, while pumps are constructed replace the loss of the diversion structure.

Action 1.3.1 Operations after May 14, 2012: Operate RBDD with Gates Out

Action: No later than May 15, 2012, Reclamation shall operate RBDD with gates out all year to allow unimpeded passage for listed anadromous fish.

Action 1.3.1 Assumptions for CALSIM II Modeling Purposes

Action: Adequate permanent facilities for diversion are assumed; therefore, no constraint on diversion schedules is included in the Future condition modeling.

Action 1.3.2 Interim Operations

Action: Until May 14, 2012, Reclamation shall operate RBDD according to the following schedule:

- September 1 – June 14: Gates open. No emergency closures of gates are allowed.
- June 15 – August 31: Gates may be closed at Reclamation's discretion, if necessary to deliver water to TCCA.

Action 1.3.2 Assumptions for CALSIM II Modeling Purposes

Action: Adequate interim/temporary facilities for diversion are assumed; therefore, no constraint on diversion schedules is included in the Existing condition modeling.

6A.9.1.4 Action 1.4 Wilkins Slough Operations

Objective: Enhance the ability to manage temperatures for anadromous fish below Shasta Dam by operating Wilkins Slough in the manner that best conserves the dam's cold-water pool for summer releases.

Action: The Sacramento River Temperature Task Group shall make recommendations for Wilkins Slough minimum flows for anadromous fish in critically dry years, in lieu of the current 5,000 cfs navigation criterion to NMFS by December 1, 2009. In critically dry years, the SRTTG will make a recommendation.

Action 1.4 Assumptions for CALSIM II Modeling Purposes

Action: Current rules for relaxation of Navigational Control Point in CALSIM II (based on BA models) will be used. In CALSIM II, NCP flows are relaxed depending on allocations for agricultural contractors. Table 6A-13 is used to determine the relaxation.

Table 6A-13
NCP Flow Schedule with Relaxation

CVP Agriculture Allocation (%)	NCP Flow (cfs)
<10	3,250
10-25	3,500
25-40	4,000
40-65	4,500
>65	5,000

Rationale: The allocation-flow criteria have been used in the CALSIM II model for many years. The low allocation year relaxations were added to improve operations of Shasta Lake subject to 1.9 MAF carryover target storage. These criteria may be reevaluated subject to the requirements of Action 1.2.1

6A.9.1.5 Action 2.1 Lower American River Flow Management

Objective: To provide minimum flows for all steelhead life stages.

Action: Implement the flow schedule specified in the Water Forum's Flow Management Standard, which is summarized in Appendix 2-D of the NMFS BO.

Action 2.1 Assumptions for CALSIM II Modeling Purposes

Action: The Anadromous Fish Restoration Program Minimum Release Requirements (MRR) range from 800 to 2,000 cfs based on a sequence of seasonal indices and adjustments. The minimum Nimbus Dam release requirement is determined by applying the appropriate water availability index (Index Flow). Three water availability indices (i.e., Four Reservoir Index (FRI), Sacramento River Index (SRI), and the Impaired Folsom Inflow Index are applied during different times of the year, which provides adaptive flexibility in response to changing hydrological and operational conditions.

During some months, Prescriptive Adjustments may be applied to the Index Flow, resulting in the MRR. If there is no Prescriptive Adjustment, the MRR is equal to the Index Flow.

Discretionary Adjustments for water conservation or fish protection may be applied during the period extending from June through October. If Discretionary Adjustments are applied, then the resultant flows are referred to as the Adjusted Minimum Release Requirement (Adjusted MRR).

The MRR and Adjusted MRR may be suspended in the event of extremely dry conditions, represented by "conference years" or "off-ramp criteria." Conference years are defined when the projected March through November unimpaired inflow into Folsom Reservoir is less than 400,000 acre-feet. Off-ramp criteria are triggered if forecast Folsom Reservoir storage at any time during the next twelve months is less than 200,000 acre-feet.

Rationale: Minimum instream flow schedule specified in the Water Forum's Flow Management Standard is implemented in the model.

Action 2.2 Lower American River Temperature Management

Objective: Maintain suitable temperatures to support over-summer rearing of juvenile steelhead in the lower American River.

Action: Reclamation shall develop a temperature management plan that contains: (1) forecasts of hydrology and storage; (2) a modeling run or runs, using these forecasts, demonstrating that the temperature compliance point can be attained (see Coldwater Management Pool Model approach in Appendix 2-D); (3) a plan of operation based on this modeling run that demonstrates that all other non-discretionary requirements are met; and (4) allocations for discretionary deliveries that conform to the plan of operation.

Action 2.2 Assumptions for CALSIM II Modeling Purposes

Action: The flows in the model reflect the Anadromous Fish Restoration Program implemented under Action 2.1. It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: Temperature models of Folsom Lake and the American River were developed in the 1990s. Model development for long range planning purposes may be required. Further analysis using a verified long range planning level temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably

6A.9.1.6 Action Suite 3.1 Stanislaus River / Eastside Division Actions

Overall Objectives: (1) Provide sufficient definition of operational criteria for Eastside Division to ensure viability of the steelhead population on the Stanislaus River, including freshwater migration routes to and from the Delta; and (2) halt or reverse adverse modification of steelhead critical habitat.

Action 3.1.2 Provide Cold-water Releases to Maintain Suitable Steelhead Temperatures

Action: Reclamation shall manage the cold-water supply within New Melones Reservoir and make cold-water releases from New Melones Reservoir to provide suitable temperatures for Central Valley steelhead rearing, spawning, egg incubation smoltification, and adult migration in the Stanislaus River downstream of Goodwin Dam.

Action 3.1.2 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flow operations resulting from the minimum flow requirements described in Action 3.1.3.

Rationale: Temperature models of New Melones Lake and the Stanislaus River have been developed by Reclamation. Further analysis using this or another temperature model can further verify that temperature operations perform reasonably well with flows included in model and temperatures are met reliably. Development of temperature model runs is needed to refine the flow schedules assumed.

Action 3.1.3 Operate the East Side Division Dams to Meet the Minimum Flows, as Measured at Goodwin Dam

Objective: To maintain minimum base flows to optimize Central Valley steelhead habitat for all life history stages and to incorporate habitat maintaining geomorphic flows in a flow pattern that will provide migratory cues to smolts and facilitate out-migrant smolt movement on declining limb of pulse.

Action: Reclamation shall operate releases from the East Side Division reservoirs to achieve a minimum flow schedule as prescribed in NMFS BO Appendix 2-E and generally described on Figure 11-1. When operating at higher flows than specified, Reclamation shall implement ramping rates for flow changes that will avoid stranding and other adverse effects on Central Valley steelhead.

Action 3.1.3 Assumptions for CALSIM II Modeling Purposes

Action: Minimum flows based on Appendix 2-E flows (presented in Figure 6A-3) are assumed consistent to what was modeled by NMFS (5/14/09 and 5/15/09 CALSIM II models provided by NMFS; relevant logic merged into baselines models).

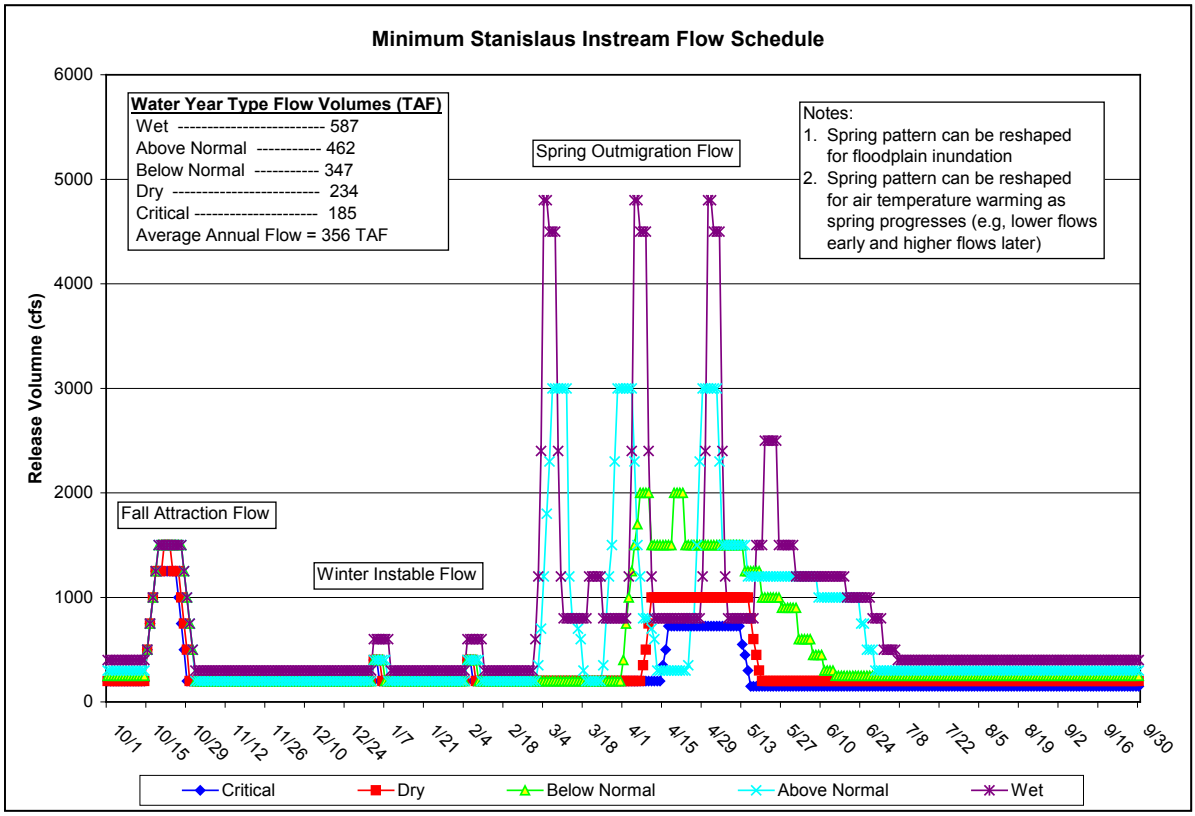

Figure 6A-3. Minimum Stanislaus Instream Flow Schedule as Prescribed in Appendix 2-E of the NMFS BO (06/04/09)

Annual allocation in New Melones is modeled to ensure availability of required instream flows (Table 6A-14) based on a water supply forecast that is comprised of end-of-February New Melones storage (in TAF) plus forecast inflow to New Melones from March 1 to September 30 (in TAF). The "forecast inflow" is calculated using perfect foresight in the model. Allocated volume of water is released according to water year type following the monthly flow schedule illustrated in Figure 6A-3.

Table 6A-14
New Melones Allocations to Meet Minimum Instream Flow Requirements

New Melones Index (TAF)	Annual Allocation Required for Instream Flows (TAF)
<1000	0-98.9
1,000 – 1,399	98.9
1,400 – 1,724	185.3
1,725 – 2,177	234.1
2,178 – 2,386	346.7
2,387 – 2,761	461.7
2,762 – 6,000	586.9

Rationale: This approach was reviewed by National Oceanic and Atmospheric Administration (NOAA) fisheries and verified that the year typing and New Melones allocation scheme are consistent with the modeling prepared for the BO.

6A.9.1.7 Action Suite 4.1 DCC Gate Operation, and Engineering Studies of Methods to Reduce Loss of Salmonids in Georgiana Slough and Interior Delta

Action 4.1.2 DCC Gate Operation

Objective: Modify DCC gate operation to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January.

Action: Between November 1 and June 15, DCC gate operations will be modified from the proposed action to reduce loss of emigrating salmonids and green sturgeon. From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures/modified Salmon Decision Tree.

Timing: November 1 through June 15.

Triggers: Action triggers and description of action as defined in NMFS BO are presented in Table 6A-15.

Table 6A-15
NMFS BO DCC Gate Operation Triggers and Actions

Date	Action Triggers	Action Responses
October 1 – November 30	Water quality criteria per D-1641 are met and either the KLCI or the SCI are greater than three fish per day but less than or equal to five fish per day.	Within 24 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days.
	Water quality criteria per D-1641 are met and either the KLCI or SCI is greater than five fish per day	Within 24 hours, close the DCC gates and keep closed until the catch index is less than three fish per day at both the Knights Landing and Sacramento monitoring sites.
	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria.	Delta Operations for Salmon and Sturgeon reviews monitoring data and makes recommendation to NMFS and Water Operations Management Team per procedures in Action IV.5.
December 1 – December 14	Water quality criteria are met per D-1641.	DCC gates are closed. If Chinook salmon migration experiments are conducted during this period (e.g., Delta Action 8 or similar studies), the DCC gates may be opened according to the experimental design, with NMFS' prior approval of the study.
	Water quality criteria are not met but both the KLCI and SCI are less than three fish per day.	DCC gates may be opened until the water quality criteria are met. Once water quality criteria are met, the DCC gates will be closed within 24 hours of compliance.
	Water quality criteria are not met but either of the KLCI or SCI is greater than three fish per day.	Delta Operations for Salmon and Sturgeon reviews monitoring data and makes recommendation to NMFS and Water

Date	Action Triggers	Action Responses
		Operations Management Team per procedures in Action IV.5
December 15 – January 31	December 15-January 31.	DCC Gates Closed.
	NMFS-approved experiments are being conducted.	Agency sponsoring the experiment may request gate opening for up to 5 days; NMFS will determine whether opening is consistent with Endangered Species Act obligations.
	One-time event between December 15 to January 5, when necessary to maintain Delta water quality in response to the astronomical high tide, coupled with low inflow conditions.	Upon concurrence of NMFS, DCC Gates may be opened 1 hour after sunrise to 1 hour before sunset, for up to 3 days, then return to full closure. Reclamation and DWR will also reduce Delta exports down to a health and safety level during the period of this action.
February 1 – May 15	D-1641 mandatory gate closure.	Gates closed, per WQCP criteria
May 16 – June 15	D-1641 gate operations criteria	DCC gates may be closed for up to 14 days during this period, per 2006 WQCP, if NMFS determines it is necessary.

Notes:

KLCI = Knights Landing Catch Index

SCI = Sacramento Catch Index

Action 4.1.2 Assumptions for CALSIM II Modeling Purposes

Action: The DCC gate operations for October 1 through January 31 were layered on top of the D-1641 gate operations already included in the CALSIM II model. The general assumptions regarding the NMFS DCC operations are summarized in Table 6A-16.

Timing: October 1 through January 31.

Table 6A-16
DCC Gate Operation Triggers and Actions as Modeled in CALSIM II

Date	Modeled Action Triggers	Modeled Action Responses
October 1-December 14	Sacramento River daily flow at Wilkins Slough exceeding 7,500 cfs; flow assumed to flush salmon into the Delta	Each month, the DCC gates are closed for number of days estimated to exceed the threshold value.
	Water quality conditions at Rock Slough subject to D-1641 standards	Each month, the DCC gates are not closed if it results in violation of the D-1641 standard for Rock Slough; if DCC gates are not closed due to water quality conditions, exports during the days in question are restricted to 2,000 cfs.
December 15 – January 31	December 15-January 31	DCC Gates Closed.

Flow Trigger: It is assumed that during October 1 – December 14, the DCC will be closed if Sacramento River daily flow at Wilkins Slough exceeds 7,500 cfs. Using historical data (1945 through 2003, U.S.

Geological Survey gauge 11390500 "Sacramento River below Wilkins Slough near Grimes, CA"), a linear relationship is obtained between average monthly flow at Wilkins Slough and the number of days in month where the flow exceeds 7,500 cfs. This relation is then used to estimate the number of days of DCC closure for the October 1 – December 14 period (Figure 6A-4).

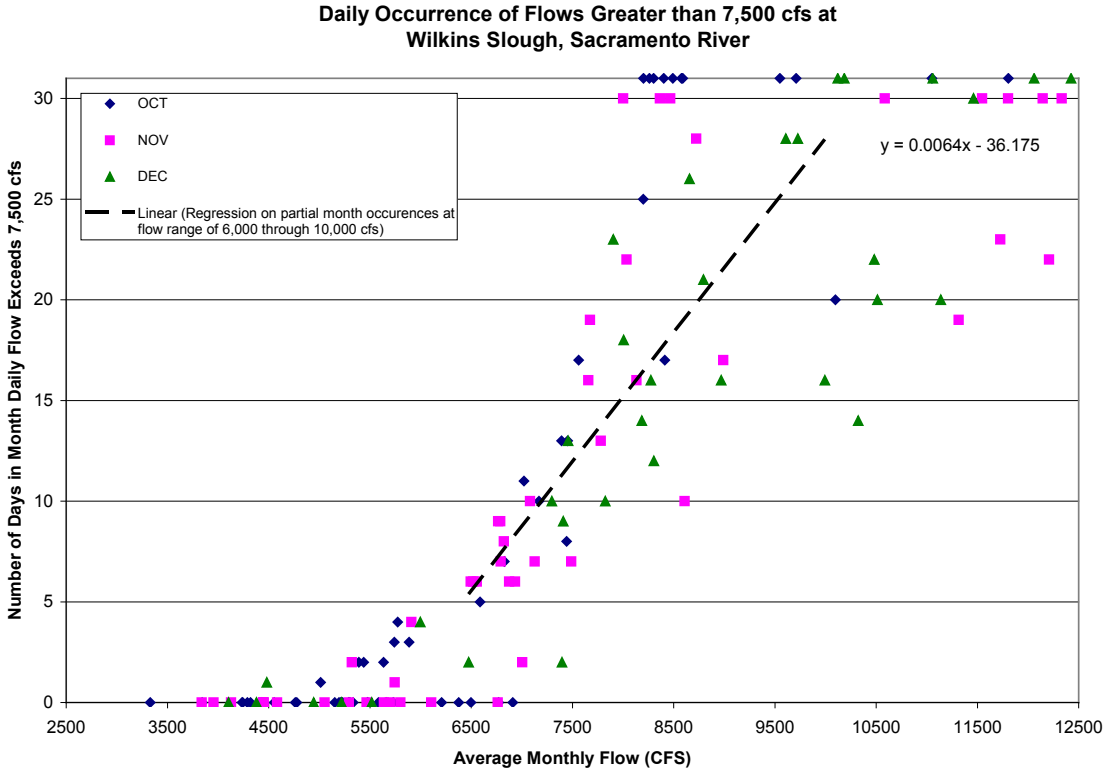

Figure 6A-4. Relationship between Monthly Averages of Sacramento River Flows and Number of Days that Daily Flow Exceeds 7,500 cfs in a Month at Wilkins Slough

It is assumed that during December 15 through January 31 that the DCC gates are closed under all flow conditions.

Water Quality: It is assumed that during October 1 – December 14 the DCC gates may remain open if water quality is a concern. Using the CALSIM II-ANN flow-salinity model for Rock Slough, current month's chloride level at Rock Slough is estimated assuming DCC closure per NMFS BO. The estimated chloride level is compared against the Rock Slough chloride standard (monthly average). If estimated chloride level exceeds the standard, the gate closure is modeled per D-1641 schedule (for the entire month).

It is assumed that during December 15 through January 31 that the DCC gates are closed under all water quality conditions.

Export Restriction: During October 1 – December 14 period, if the flow trigger condition is such that additional days of DCC gates closed is called for; however, water quality conditions are a concern and the DCC gates remain open, then Delta exports are limited to 2,000 cfs for each day in question. A monthly Delta export restriction is calculated based on the trigger and water quality conditions described above.

Rationale: The proposed representation in CALSIM II should adequately represent the limited water quality concerns were Sacramento River flows are low during the extreme high tides of December.

6A.9.1.8 Action Suite 4.2 Delta Flow Management

Action 4.2.1 San Joaquin River Inflow to Export Ratio

Objectives: To reduce the vulnerability of emigrating Central Valley steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio. To enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: For CVP and SWP operations under this action, "The Phase II: Operations beginning is 2012" is assumed. From April 1 through May 31, 1) Reclamation shall continue to implement the Goodwin flow schedule for the Stanislaus River prescribed in Action 3.1.3 and Appendix 2-E of the NMFS BO); and 2) combined CVP and SWP exports shall be restricted to the ratio depicted in Table 6A-17, based on the applicable San Joaquin River Index, but will be no less than 1,500 cfs (consistent with the health and safety provision governing this action.)

Action 4.2.1 Assumptions for CALSIM II Modeling Purposes

Action: Flows at Vernalis during April and May will be based on the Stanislaus River flow prescribed in Action 3.1.3 and the flow contributions from the rest of the San Joaquin River basin consistent with the representation of VAMP contained in the BA modeling. In many years this flow may be less than the minimum Vernalis flow identified in the NOAA BO.

Exports are restricted as illustrated in Table 6A-17.

Table 6A-17
Maximum Combined CVP and SWP Export during April and May

San Joaquin River Index	Combined CVP and SWP Export Ratio
Critically Dry	1:1
Dry	2:1
Below Normal	3:1
Above Normal	4:1
Wet	4:1

Rationale: Although the described model representation does not produce the full Vernalis flow objective outlined in the NOAA BO, it does include the elements that are within the control of the CVP and SWP, and that are reasonably certain to occur for the purpose of the EIS/EIR modeling.

In the long-term, a future SWRCB flow standard at Vernalis may potentially incorporate the full flow objective identified in the BO; and the Merced and Tuolumne flows would be based on the outcome of the current SWRCB and FERC processes that are underway.

Action 4.2.3 Old and Middle River Flow Management

Objective: Reduce the vulnerability of emigrating juvenile winter-run, yearling spring-run, and Central Valley steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of

the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta. Enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the mainstem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: From January 1 through June 15, reduce exports, as necessary, to limit negative flows to -2,500 to -5,000 cfs in OMRs, depending on the presence of salmonids. The reverse flow will be managed within this range to reduce flows toward the pumps during periods of increased salmonid presence. Refer to NMFS BO document for the negative flow objective decision tree.

Action 4.2.3 Assumptions for CALSIM II Modeling Purposes

Action: OMR flows required in this BO are assumed to be covered by OMR flow requirements developed for actions 1 through 3 of the USFWS BO Most Likely scenario (Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies – DRAFT, 6/10/09).

Rationale: Based on a review of available data, it appears that implementation of actions 1 through 3 of the USFWS RPA, and action 4.2.1 of the NOAA RPA will adequately cover this action within the CALSIM II simulation. If necessary, additional post-processing of results could be conducted to verify this assumption.

6A.10 References

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Attachment 6A-1
Delivery Specifications

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Table B-30. Delta - Baselines - Future Conditions

SWP CONTRACTOR	Geographic Location	CALSIM II Diversion	Water Right (TAF/yr)	SWP Table A Amount (TAF)		SWP Article 21 Demand (TAF/mon)	CVP Water Service Contracts (TAF/yr)		Other (TAF/yr)
				Ag	M&I		AG	M&I	
North Delta									
City of Vallejo	City of Vallejo	D403A						16.0	
CCWD[a]	Contra Costa County	D420						195.0	
Napa County FC&WCD	North Bay Aqueduct	D403B			29.02	1.0			
Solano County WA	North Bay Aqueduct	D403C			47.76	1.0			
Fairfield, Vacaville and Benecia Agreement	North Bay Aqueduct	D403D	31.60						
City of Antioch	City of Antioch	D406B	18.0						
Total North Delta			49.6	0.0	76.8	2.0	0.0	211.0	
South Delta									
Delta Water Supply Project	City of Stockton	D514A	32.4						
Total South Delta			32.4	0.0	0.0	0.0	0.0	0.0	
Total			82.0	0.0	76.8	2.0	0.0	211.0	

a The new Los Vaqueros module in CALSIM II is used to determine the range of demands that are met by CVP contracts or other water rights.

Table B-31. SWP North-of-the-Delta - Baselines - Future Conditions

SWP CONTRACTOR	Geographic Location	CALSIM II Diversion	FRSA Amount (TAF)	Water Right (TAF/yr)	Table A Amount (TAF)		Article 21 Demand (TAF/mon)	Other (TAF/yr)
					Ag	M&I		
Feather River								
Palermo	FRSA	D6		17.6				
County of Butte	Feather River	D201				27.5		
Thermalito	FRSA	D202		8.0				
Western Canal	FRSA	D7A	150.0	145.0				
Joint Board	FRSA	D7B	550.0	5.0				
City of Yuba City	Feather River	D204				9.6		
Feather WD	FRSA	D206A	17.0					
Garden, Oswald, Joint Board	FRSA	D206B						
Garden	FRSA	D206BA	12.9	5.1				
Oswald	FRSA	D206BB	2.9					
Joint Board	FRSA	D206BC	50.0					
Plumas, Tudor	FRSA	D206C						
Plumas	FRSA	D206CA	8.0	6.0				
Tudor	FRSA	D206CB	5.1	0.2				
Total Feather River Area			795.8	186.9	0.0	37.1		
Other								
Yuba County Water Agency	Yuba River	D230						Variable 333.6
Camp Far West ID	Yuba River	D285						12.6
Bear River Exports	American R/DSA70	D283						Variable 95.2
Feather River Exports to American River (left bank to DSA70)	American R/DSA70	D223		11.0				

Table B-32. SWP South-of-the-Delta - Baselines - Future Conditions

SWP CONTRACTOR	Geographic Location	CALSIM II Diversion	Table A Amount (TAF)		Article 21 Demand (TAF/mon)	Losses (TAF/yr)
			Ag	M&I		
Alameda Co. FC&WCD, Zone 7	SBA reaches 1-4	D810		51.74	1.00	
	SBA reaches 5-6	D813		28.88	None	
		Total		80.62	1.00	
Alameda County WD	SBA reaches 7-8	D814		42.00	1.00	
Santa Clara Valley WD	SBA reach 9	D815		100.00	4.00	
Oak Flat WD	CA reach 2A	D802	5.70		None	
County of Kings	CA reach 8C	D847	9.00		None	
Dudley Ridge WD	CA reach 8D	D849	57.34		1.00	
Empire West Side ID	CA reach 8C	D846	3.00		1.00	
Kern County Water Agency	CA reaches 3, 9-13B	D851	600.61	134.60	None	
	CA reaches 14A-C	D859	111.68		180.00	
	CA reaches 15A-16A	D863	62.77		None	
	CA reach 31A	D867	73.07		None	
		Total	848.13	134.60	180.00	
Tulare Lake Basin WSD	CA reaches 8C-8D	D848	96.23		15.00	
San Luis Obispo Co. FC&WCD	CA reaches 33A-35	D869		25.00	None	
Santa Barbara Co. FC&WCD	CA reach 35	D870		45.49	None	
Antelope Valley-East Kern WA	CA reaches 19-20B, 22A-B	D877		141.40	1.00	
Castaic Lake WA	CA reach 31A	D868	12.70		1.00	
	CA reach 30	D896		82.50	None	
		Total	12.70	82.50	1.00	
Coachella Valley WD	CA reach 26A	D883		133.10	2.00	
Crestline-Lake Arrowhead WA	CA reach 24	D25		5.80	None	
Desert WA	CA reach 26A	D884		54.00	5.00	
Littlerock Creek ID	CA reach 21	D879		2.30	None	
Mojave WA	CA reaches 19, 22B-23	D881		75.80	None	

Table B-32. SWP South-of-the-Delta - Baselines - Future Conditions

SWP CONTRACTOR	Geographic Location	CALSIM II Diversion	Table A Amount (TAF) Ag	Table A Amount (TAF) M&I	Article 21 Demand (TAF/mon)	Losses (TAF/yr)
Metropolitan WDSC	CA reach 26A	D885		778.13	90.70	
	CA reach 30	D895		719.66	74.80	
	CA reaches 28G-H	D899		410.31	27.60	
	CA reach 28J	D27		3.40	6.90	
		Total		1911.50	200.00	
Palmdale WD	CA reaches 20A-B	D878		21.30	None	
San Bernardino Valley MWD	CA reach 26A	D886		102.60	None	
San Gabriel Valley MWD	CA reach 26A	D887		28.80	None	
San Gorgonio Pass WA	CA reach 26A	D888		17.30	None	
Ventura County FCD	CA reach 29H	D28		3.15	None	
	CA reach 30	D29		16.85	None	
		Total		20.00		
SWP Losses	CA reaches 1-2	D803				7.70
	SBA reaches 1-9	D816				0.60
	CA reach 3	D824				10.80
	CA reach 4	D826				2.60
	CA reach 5	D827				3.90
	CA reach 6	D828				1.20
	CA reach 7	D829				1.60
	CA reaches 8C-13B	D854				11.90
	Wheeler Ridge PP and CA reaches 14A-C	D862				3.60
	Chrisman PP and CA reaches 15A-18A	D864				1.80
	Pearblossom PP and CA reaches 17-21	D880				5.10
	Mojave PP and CA reaches 22A-23	D882				4.00
	REC and CA reaches 24-28J	D889				1.40
	CA reaches 29A-29F	D891				1.90
	Castaic PWP and CA reach 29H	D893				3.10
	REC and CA reach 30	D894				2.40
Total						63.60
Total			1032.10	3024.11	412.00	63.60

Table B-33. CVP North-of-the-Delta - Baselines - Future Conditions

CVP CONTRACTOR	Geographic Location	CALSIM II Representation		CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights/Non-CVP(TAF/yr)	Level 2 Refuges[a] (TAF/yr)
		Diversion	Region	AG	M&I			
Anderson Cottonwood ID	Sacramento River Redding Subbasin	D104A	DSA 58			128.0		
Clear Creek CSD		D104B	DSA 58	13.8	1.5			
Bella Vista WD		D104C	DSA 58	22.1	2.4			
Shasta CSD		D104D	DSA 58		1.0			
Sac R. Misc. Users		D104F	DSA 58			3.4		
Redding, City of		D104G	DSA 58			21.0		
City of Shasta Lake		D104H	DSA 58	2.5	0.3			
Mountain Gate CSD		D104I	DSA 58		0.4			
Shasta County Water Agency		D104J	DSA 58	0.5	0.5			
Redding, City of/Buckeye		D104K	DSA 58		6.1			
Total		D104		38.9	12.2	152.4		0.0
Corning WD	Corning Canal	D171	WBA 4	23.0				
Proberta WD		D171	WBA 4	3.5				
Thomes Creek WD		D171	WBA 4	6.4				
Total				32.9	0.0	0.0		0.0
Kirkwood WD	Tehama-Colusa Canal	D172	WBA 4	2.1				
Glide WD		D174	WBA 7N	10.5				
Kanawha WD		D174	WBA 7N	45.0				
Orland-Artois WD		D174	WBA 7N	53.0				
Colusa, County of		D178	WBA 7S	20.0				
Colusa County WD		D178	WBA 7S	62.2				
Davis WD		D178	WBA 7S	4.0				
Dunnigan WD		D178	WBA 7S	19.0				
La Grande WD		D178	WBA 7S	5.0				
Westside WD		D178	WBA 7S	65.0				
Total				285.8	0.0	0.0		0.0
Sac. River Misc. Users	Sacramento River	D113A	WBA 4			1.5		

Table B-33. CVP North-of-the-Delta - Baselines - Future Conditions

CVP CONTRACTOR	Geographic Location	CALSIM II Representation		CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights/Non-CVP(TAF/yr)	Level 2 Refuges[a] (TAF/yr)
		Diversion	Region	AG	M&I			
Glenn Colusa ID	Glenn-Colusa Canal	D143A	WBA 8NN			441.5		
		D145A	WBA 8NS			383.5		
Sacramento NWR		D143B	WBA 8NN					53.4
Delevan NWR		D145B	WBA 8NS					24.0
Colusa NWR		D145B	WBA 8NS					28.8
Colusa Drain M.W.C.	Colusa Basin Drain	D180	WBA 8NN			7.7		
		D182A/ D18302	WBA 8NS			62.3		
Total				0.0	0.0	895.0		106.2
Princeton-Cordova-Glenn ID	Sacramento River	D122A	WBA 8NN			67.8		
Provident ID		D122A	WBA 8NN			54.7		
Maxwell ID		D122A	WBA 8NN			1.8		
		D122B	WBA 8NS			16.2		
Sycamore Family Trust		D122B	WBA 8NS			31.8		
Roberts Ditch IC		D122B	WBA 8NS			4.4		
Sac R. Misc. Users		D122A	WBA 8NN			4.9		
		D122B	WBA 8NS			9.5		
Total				0.0	0.0	191.2		0.0
Reclamation District 108	Sacramento River	D122B	WBA 8NS			12.9		
		D129A	WBA 8S			219.1		
River Garden Farms		D129A	WBA 8S			29.8		
Meridian Farms WC		D128	DSA 15			35.0		
Pelger Mutual WC		D128	DSA 15			8.9		
Reclamation District 1004		D128	DSA 15			71.4		
Carter MWC		D128	DSA 15			4.7		
Sutter MWC		D128	DSA 15			226.0		
Tisdale Irrigation & Drainage Co.		D128	DSA 15			9.9		
Sac R. Misc. Users		D128	DSA 15			103.4		
		D129A	WBA 8S			0.9		
Feather River WD export		D128	DSA 15	20.0				
Total				20.0	0.0	722.1		0.0

Table B-33. CVP North-of-the-Delta - Baselines - Future Conditions

CVP CONTRACTOR	Geographic Location	CALSIM II Representation		CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights/Non-CVP(TAF/yr)	Level 2 Refuges[a] (TAF/yr)
		Diversion	Region	AG	M&I			
Sutter NWR	Sutter bypass water for Sutter NWR	C136B	DSA 69					25.9
Gray Lodge WMA	Feather River	C216B	DSA 69					41.4
Butte Sink Duck Clubs		C221	DSA 69					15.9
Total				0.0	0.0	0.0		83.2
Sac R. Misc. Users	Sacramento River	D163	DSA 65			56.8		
City of West Sacramento		D165	DSA 65			23.6		
Davis-Woodland Water Supply Project		D165	DSA 65	DSA 65				
Total				0.0	0.0	80.4		0.0
Sac R. Misc. Users	Lower Sacramento River	D162A	DSA 70			4.8		
Natomas Central MWC		D162B	DSA 70			120.2		
Pleasant Grove-Verona MWC		D162C	DSA 70			26.3		
City of Sacramento (PCWA)		D162D	DSA 70		0.0		0.0	
PCWA (Water Rights)		D162E	DSA 70		0.0		0.0	
Total				0.0	0.0	151.3	0.0	
Total CVP North-of-Delta				377.6	12.2	2193.8	0.0	189.4

[a] *Level 4 Refuge water needs are not included.*

[b] *Refer to Table 8 for more information*

Table B-34. CVP and Water Rights for American River - Baselines - Future Conditions

CVP CONTRACTOR	Geographic Location	CALSIM II Diversion	CVP Water Service Contracts (TAF/yr)		Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Diversion Limits (TAF/Yr)	Foot-notes
			AG	M&I[1]				
Placer County Water Agency	Auburn Dam Site	D300		0.0		35.5	35.5	
Sacramento Suburban Water District[2]	Folsom Reservoir	D8A				17.0	17.0	
City of Folsom (includes P.L. 101-514)		D8B		7.0		27.0	34.0	1
Folsom Prison		D8C				5.0	5.0	
San Juan Water District (Placer County)		D8D				24.0	24.0	
San Juan Water District (Sac County) (includes P.L. 101-514)		D8E		24.2		33.0	57.2	1
El Dorado Irrigation District		D8F		7.55		17.0	24.55	1
City of Roseville		D8G		32.0		5.0	37.0	1
Placer County Water Agency		D8H		35.0			35.0	
El Dorado County (P.L. 101-514)		D8I		15.0			15.0	1
Total			0.0	120.8	0.0	128.0	248.8	
So. Cal WC/ Arden Cordova WC	Folsom South Canal	D9AA				5.0	5.0	
California Parks and Recreation		D9AB		5.0			5.0	1
SMUD (export)		D9B		30.0		15.0	45.0	1
Canal Losses		D9A				1.0	1.0	
Total			0.0	35.0	0.0	21.0	56.0	
City of Sacramento[3]	Lower American River	D302A				82.26	82.26	
Carmichael Water District		D302C				12.0	12.0	
Total			0.0	0.0	0.0	94.3	94.3	
City of Sacramento	Lower Sacramento River	D167A				162.74	162.74	
Sacramento County Water Agency (including SMUD transfer)		D167B		10.0			10.0	
		D168C		20.0			20.0	
Sacramento County Water Agency (P.L. 101-514)		D168C		15.0			15.0	
Sacramento County Water Agency - assumed Appropriated Water		D168C				varies[4]	varies[4]	2
EBMUD (export)		D168B		133.0			varies[5]	3
Total			0.0	178.0	0.0	varies[4]	varies[4,5]	
Total			0.0	333.75	0.0	varies[4]	varies[4,5]	

Table B-35. CVP South-of-the-Delta - Baselines - Future Conditions

CVP CONTRACTOR	Geographic Location	CALSIM II Diversion	CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non-CVP (TAF/yr)	Level 2 Refuges[a] (TAF/yr)	Losses (TAF/yr)
			AG	M&I				
Byron-Bethany ID	Upper DMC	D700	20.6					
Tracy, City of		D700		10.0				
		D700		5.0				
		D700		5.0				
Banta Carbona ID		D700	20.0					
Total		D700	40.6	20.0	0.0	0.0	0.0	0.0
Del Puerto WD	Upper DMC	D701	12.1					
Davis WD		D701	5.4					
Foothill WD		D701	10.8					
Hospital WD		D701	34.1					
Kern Canon WD		D701	7.7					
Mustang WD		D701	14.7					
Orestimba WD		D701	15.9					
Quinto WD		D701	8.6					
Romero WD		D701	5.2					
Salado WD		D701	9.1					
Sunflower WD		D701	16.6					
West Stanislaus WD		D701	50.0					
Patterson WD		D701	16.5			6.0		
Total		D701	206.7	0.0	0.0	6.0	0.0	0.0
Upper DMC Loss	Upper DMC	D702						18.5
Panoche WD	Lower DMC Volta	D706	6.6					
San Luis WD		D706	65.0					
Laguna WD		D706	0.8					
Eagle Field WD		D706	4.6					
Mercy Springs WD		D706	2.8					
Oro Loma WD		D706	4.6					
Total		D706	84.4	0.0	0.0	0.0	0.0	0.0
Upper DMC Exchange Contractors	Lower DMC Volta	D707						
Central California ID		D707			140.0			

Table B-35. CVP South-of-the-Delta - Baselines - Future Conditions

CVP CONTRACTOR	Geographic Location	CALSIM II Diversion	CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non-CVP (TAF/yr)	Level 2 Refuges[a] (TAF/yr)	Losses (TAF/yr)
			AG	M&I				
Grasslands via CCID	Lower DMC Volta	D708					81.8	
Los Banos WMA		D708					11.2	
Kesterson NWR	Lower DMC Volta	D708					10.5	
Freitas - SJBAP		D708					6.3	
Salt Slough - SJBAP		D708					8.6	
China Island - SJBAP		D708					7.0	
Volta WMA		D708					13.0	
Grassland via Volta Wasteway		D708					23.2	
Total		D708	0.0	0.0	140.0	0.0	161.5	0.0
Fresno Slough WD	San Joaquin River at Mendota Pool	D607A	4.0			0.9		
James ID		D607A	35.3			9.7		
Coelho Family Trust		D607A	2.1			1.3		
Tranquillity ID		D607A	13.8			20.2		
Tranquillity PUD		D607A	0.1			0.1		
Reclamation District 1606		D607A	0.2			0.3		
Exchange Contractors		D607B						
Central California ID		D607B			392.4			
Columbia Canal Co.		D607B			59.0			
Firebaugh Canal Co.		D607B			85.0			
San Luis Canal Co.		D607B			23.6			
M.L. Dudley Company		D607B				2.3		
Grasslands WD		D607C					29.0	
Mendota WMA		D607C					27.6	
Losses		D607D						101.5
Total		D607	55.5	0.0	560.0	34.8	56.6	101.5
Exchange Contractors	San Joaquin River at Sack Dam	D608B						
San Luis Canal Co.		D608B			140.0			
Grasslands WD		D608C					2.3	
Los Banos WMA		D608C					12.4	
San Luis NWR		D608C					19.5	
West Bear Creek NWR		D608C					7.5	
East Bear Creek NWR		D608C					8.9	
Total		D608	0.0	0.0	140.0	0.0	50.6	0.0

Table B-35. CVP South-of-the-Delta - Baselines - Future Conditions

CVP CONTRACTOR	Geographic Location	CALSIM II Diversion	CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non-CVP (TAF/yr)	Level 2 Refuges[a] (TAF/yr)	Losses (TAF/yr)
			AG	M&I				
San Benito County WD (Ag)	San Felipe	D710	35.6					
Santa Clara Valley WD (Ag)		D710	33.1					
Pajaro Valley WD		D710	6.3					
San Benito County WD (M&I)		D711		8.3				
Santa Clara Valley WD (M&I)		D711		119.4				
Total		D710/D711	74.9	127.7	0.0	0.0	0.0	0.0
San Luis WD	CA reach 3	D833	60.1					
CA, State Parks and Rec		D833	2.3					
Affonso/Los Banos Gravel Co.		D833	0.3					
Total		D833	62.6	0.0	0.0	0.0	0.0	0.0
Panoche WD	CVP Dos Amigos PP/ CA reach 4	D835	87.4					
Pacheco WD		D835	10.1					
Total		D835	97.5	0.0	0.0	0.0	0.0	0.0
Westlands WD (Centinella)	CA reach 4	D836	2.5					
Westlands WD (Broadview WD)		D836	27.0					
Westlands WD (Mercy Springs WD)		D836	4.2					
Westlands WD (Widern WD)		D836	3.0					
Total		D836	36.7	0.0	0.0	0.0	0.0	0.0
Westlands WD: CA Joint Reach 4	CA reach 4	D837	219.0					
Westlands WD: CA Joint Reach 5	CA reach 5	D839	570.0					
Westlands WD: CA Joint Reach 6	CA reach 6	D841	219.0					
Westlands WD: CA Joint Reach 7	CA reach 7	D843	142.0					
Total			1150.0	0.0	0.0	0.0	0.0	0.0
Avenal, City of	CA reach 7	D844		3.5		3.5		
Coalinga, City of		D844		10.0				
Huron, City of		D844		3.0				
Total		D844	0.0	16.5	0.0	3.5	0.0	0.0

Table B-35. CVP South-of-the-Delta - Baselines - Future Conditions

CVP CONTRACTOR	Geographic Location	CALSIM II Diversion	CVP Water Service Contracts (TAF/yr)		Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non-CVP (TAF/yr)	Level 2 Refuges[a] (TAF/yr)	Losses (TAF/yr)
			AG	M&I				
CA Joint Reach 3 - Loss	CVP Dos Amigos PP/CA reach 3	D834						2.5
CA Joint Reach 4 - Loss	CA reach 4	D838						10.1
CA Joint Reach 5 - Loss	CA reach 5	D840						30.1
CA Joint Reach 6 - Loss	CA reach 6	D842						12.5
CA Joint Reach 7 - Loss	CA reach 7	D845						8.5
Total			0.0	0.0	0.0	0.0	0.0	63.7
Cross Valley Canal - CVP	CA reach 14							
Fresno, County of		D855	3.0					
Hills Valley ID-Amendatory		D855	3.3					
Kern-Tulare WD		D855	40.0					
Lower Tule River ID		D855	31.1					
Pixley ID		D855	31.1					
Rag Gulch WD		D855	13.3					
Tri-Valley WD		D855	1.1					
Tulare, County of		D855	5.3					
Kern NWR		D856					11.0	
Pixley NWR		D856					1.3	
Total			128.3	0.0	0.0	0.0	12.3	0.0
Total CVP South-of-Delta			1937.1	164.2	840.0	44.3	281.0	183.7

[a] *Level 4 Refuge water needs are not included*

Table B-36. - Sacramento River Miscellaneous Users Breakdown by CALSIM II Arc locationa - Baselines - Future Conditions

CVP CONTRACTOR	CALSIM II Representation			Geographic Location		Settlement Contractor Supply (AF/year)		
	Diversion	DSA	WBA	River Mile	Bank (Left, Right)	Base	Project	Total
Riverview Golf & Country Club	D104F	58	3	240.8	L	255	25	280
Daniell, Harry				240.3	L	13	7	20
Redding Rancheria (Frmrly High-Low Nursery)				240.2	L	70	135	205
Lake Cal. Property Owners Assn			2	221	R	580	200	780
Leviathan, Inc.				221	R	355	345	700
Driscoll Strawberry Associates, Inc.			3	207.5	L	330	490	820
J. B. Unlimited, Inc.				197	L	220	290	510
Micke, Daniel & Nina				196.6	L	81	19	100
Gjermann, Hal				196.55	L	8	4	12
Total	D104F					1,912	1,515	3,427
Meyer, Herbert (Frmrly Diamond Holdings, Inc.)	D113A	58	4	191.5	R	195	230	425
Exchange Bank (The Nature Conservancy)		10		168.85	R	210	570	780
Rubio, Exequiel (Frmrly Elliott&Hadracky)				166.8	R	11	5	16
Penner, Roger & Leona				156.8	R	159	21	180
Freeman, Vola				156.1	R	11	19	30
Mclane, Robert				155.6	R	17	23	40
Alexander, Thomas Et Ux				155.6	R	9	13	22
Total	D113A					612	881	1,493
Green Valley Corp. (Frmrly Cannell, F.)	D122A	15	8NN	106	R	680	210	890
Green Valley Corp. (Frmrly Stegeman Ranch)				106	R	555	325	880
Tuttle, Charles W. - Trust				103.9	R	120	270	390
Cachil Dehe Band Of Wintun Indians(Lee Farms)				103.7	R	80	100	180
Seaver, Charles				99.3	R	200	260	460
Odysseus Farms				93.15	R	1,920	150	2,070
Total	D122A					3,555	1,315	4,870
King, Ben And Laura (Frmrly Dommer, E.)	D122B	15	8NS	89.2	R	12	7	19
King, Laura				89.2	R	13	13	26
Wisler, John W. Jr. (Frmrly Cribari, E.)				88	R	8	27	35
Mehrhof, Susan M.(frmrly.Swinford Tract)				87.7	R	164	16	180
Steidlmayer, Anthony E., Et Al.				83	R	610	700	1,310
Jansen, Peter & Sandy (Frmrly E. J. Ritchey)				70.4	R	150	40	190
Gillaspy, William & Mary (Frmrly Fay Gillaspy)				70.4	R	120	90	210
Beckley, Ralph, And Ophelia				70.4	R	165	135	300
Driver, Gary, Et Al.				69.2	R	8	22	30

Table B-36. - Sacramento River Miscellaneous Users Breakdown by CALSIM II Arc locationa - Baselines - Future Conditions

CVP CONTRACTOR	CALSIM II Representation			Geographic Location		Settlement Contractor Supply (AF/year)		
	Diversion	DSA	WBA	River Mile	Bank (Left, Right)	Base	Project	Total
Heidrick, Mildred M.	D122B	65	8NS	30.6	R	86	34	120
Tenhunfeld, F. Wallace, Jack, Et Al.				29.7	R	2,680	960	3,640
Heidrick, Mildred M.				29.2, 30.3	R	370	60	430
Hershey Land Company				28.1	R	2,570	450	3,020
Total	D122B					6,956	2,554	9,510
Pacific Realty Assoc., L.P. (M&T Chico Ranch)	D128	15	9	140.8, 141.5	L	16,980	976	17,956
Spence, Ruth Ann (Spence Farms)				104.8	L	630	100	730
Anderson, Arthur Et Al (Frmrly Westfall, Mary)				102.5	L	445	45	490
Forry, Laurie E.				99.8	L	2,285	0	2,285
Otterson, Mike (Frmrly Wells Joyce M.)				98.9	L	1,515	300	1,815
Nene Ranch, Llc (Frmrly Hollins, Mariette B.)				98.6	L	1,360	200	1,560
Griffin, Jospeh, Et Al.				95.8	L	1,610	1,150	2,760
Baber, Jack Et Al.				95.6	L	3,630	2,630	6,260
Eastside Mwc (Frmrly A&F Boeger Corp.)				95.25	L	2,170	634	2,804
Zelmar Ranch, Inc. (Frmrly Martin, Andrew)				92.5	L	112	52	164
Gomes, Judith (Frmrly. Martin, Andrew)				92.5	L	168	78	246
Butte Creek Farms				89.26	L	20	16	36
Butte Creek Farms				89.24	L	40	55	95
Butte Creek Farms (Frmrly Mayfair Farms)				88.7	L	196	8	204
Butte Creek Farms(Area 1)				88.7	L	300	340	640
Howard, Theordore W. And Linda M.				88.7	L	74	2	76
Locvich, Paul				88.2	L	80	70	150
Ehrke, Allen A. Et Ux				86.8	L	220	160	380
Fedora, Sib Et Al.				82.7	L	190	20	210
Reische, Laverne Et Ux				82.5	L	183	267	450
Reische, Eric				82.5	L	37	53	90
Tarke, Stephen & Debra				81.5	L	1,700	1,000	2,700
Churkin, Michael, Et Al.				79.5	L	75	55	130
Eggleston, Ronald Et Ux				79	L	53	12	65
Hale, Judith Et Al.				79	L	117	13	130
Hale, Judith Et Al.			18	79	L	58	17	75
Pires, Lawrence And Beverly				77.9	L	185	95	280
Davis, Ina M.				76.2	L	71	14	85
Chesney, Adona (R & A, Bypass Trust)				76.15	L	310	390	700
Andreotti, Beverly F., Et Al.				72.1	L	2,060	1,560	3,620
Mclaughlin, Jack				72	L	430	220	650
Lomo Cold Storage (& J. J. Micheli)				67.5	L	6,410	700	7,110
Anderson, R And J, Prop.				67.1	L	149	88	237

Table B-36. - Sacramento River Miscellaneous Users Breakdown by CALSIM II Arc locationa - Baselines - Future Conditions

CVP CONTRACTOR	CALSIM II Representation			Geographic Location		Settlement Contractor Supply (AF/year)		
	Diversion	DSA	WBA	River Mile	Bank (Left, Right)	Base	Project	Total
Lonon, Michael Et Al.				67.1	L	715	440	1,155
Oji Brothers Farm, Inc.				63.9	L	1,340	1,860	3,200
Young, Russell, Et Al.				63.3	L	2	8	10
Sekhon, Arjinderpal & Daljit			18	62.3	L	350	470	820
Butler, Leslie A., Et Ux				60.5, 61.8	L	180	280	460
Howald Farms Inc.				60.4	L	1,350	1,410	2,760
Kary, Carol				59.8	L	400	600	1,000
Dennis Wilson Farms (Frmrly M&L Farms (Area 1)				58.9	L	295	60	355
Lockett, William P. & Jean B.				58.3	L	370	47	417
O'brien, Janice				58.3	L	550	289	839
Wirth, Marilyn L. (Frmrly Davis, Marilyn)				57.75	L	180	340	520
Bardis, C. Et Al 9(Reynen/Broomieside Farms)				55.1	L	8,070	2,000	10,070
Wakida, Tomio				53.9	L	50	275	325
Wakida, Tomio				52.3	L	25	135	160
Nelson, Thomas L., Et Ux				52	L	38	98	136
Rauf, Abdul & Tahmina (Frmrly Forster, J.)				50	L	2,450	710	3,160
Hiatt, Thomas(Hiatt Family Trust)				49, 49.7	L	947	538	1,485
Hiatt, Thomas(Illerich, Phillip)				49	L	372	212	584
Oji, Mitsue Family Partnership	D128	15		48.7	L	3,430	1,310	4,740
Henle, Thomas N.				46.5	L	935	0	935
Windswept Land&Livestock Co. (P. Burroughs)				44.2, 45.6, 46.45	L	4,040	0	4,040
Schreiner, Joe & Cleo			19	38.8	L	180	20	200
Munson, James T., Et Ux				37.75	L	70	85	155
Klsy, Llc (Frmrly Mirbach-Harff Antonius)				37.2	L	80	90	170
Driver, John A. & Clare M.				36.45	L	150	80	230
Driver, John A. & Clare M.				36.45	L	6	10	16
Quad-H Ranches, Inc.				36.2	L	190	310	500
Giusti, Richard, Et Al.				36.2	L	850	760	1,610
Drew, Jerry				35.85	L	24	12	36
Jaeger, William, Et Al.						385	485	870
Morehead, Joseph Et Ux						115	140	255
Heidrick, Joe Jr.				33.75	L	360	200	560
Leiser, Dorothy L.				33.75	L	36	24	60
Mcm Properties Inc				33.75	L	860	610	1,470
Richter, Henry D. (Richter Brothers, Et Al.)				33.2	L	1,750	1,030	2,780
Furlan, Emile, Et Ux				32.5, 33.2	L	570	350	920
Byrd, Anna C. And Osborne, Jane				26.8, 30.5	L	1,055	200	1,255
Total	D128					76,633	26,808	103,441

Table B-36. - Sacramento River Miscellaneous Users Breakdown by CALSIM II Arc locationa - Baselines - Future Conditions

CVP CONTRACTOR	CALSIM II Representation			Geographic Location		Settlement Contractor Supply (AF/year)		
	Diversion	DSA	WBA	River Mile	Bank (Left, Right)	Base	Project	Total
Edson, Wallace L. & Mary O. *	D129A	65	8S	33.85	R	40	64	104
Driver, William A.(Frmrly Collier, T.)				32.5	R	54	106	160
Driver, Gregory E.(Frmrly Collier, T.)				32.5	R	54	106	160
Giovannetti, B.E. & Mary				31.5	R	470	50	520
Total	D129A					618	326	944
Odysseus Farms Prtnrshp.(Frmrly Leal, Robert)	D162A	70	N/A	19.6	L	220	410	630
Cummings, Wm. (Frmrly Verona Farming Prtnrshp)				18.7	L	180	120	300
Lauppe, Burton And Kathyrn				18.45	L	720	230	950
Natomas Basin Conservancy				18.2	L	221	269	490
E.L.H. Sutter Properties, Inc.				18.2	L	12	28	40
Lauppe, Burton And Kathyrn				18.2	L	153	197	350
Siddiqui, J.&A.T.				10.75	L	110	20	130
Willey, Edwin, Mr. And Mrs.				10.75	L	75	20	95
Siddiqui, Javed&Amna (Et Al.&Fmly.Partnshp.)				10.25	L	860	200	1,060
Sacramento, County Of				9.3	L	520	230	750
Total	D162A					3,071	1,724	4,795
Sacramento River Ranches(Frmrly Deseret Farms)	D163	65	N/A	16.6, 17.0, 22.5	R	4,000	0	4,000
Knaggs Walnut Ranches Co. Lp				16.1	R	630	0	630
Conway Preservation Group				12	R	50,190	672	50,862
Wilson Ranch Partnership				11.1	R	370	0	370
Reclamation Distrs. 900 And 1000 (Frm.Amen,H.)				9.35	R	281	123	404
Riverby Limited Partnership				5.25	R	470	30	500
Total	D163					55,941	825	56,766
Total						149,298	35,948	185,246

[a] *Source: Settlement contractor data provided by USBR*

Attachment 6A-2
Excerpts from "Water Supply Impact Analysis of December 2008 Delta Smelt Biological Opinion," by Paul Hutton, Metropolitan Water District of Southern California, February 2009

Entitled

"Appendix 4: Approach to Suspend Actions During High Flows" and "Appendix 5: Approach to Relate 5-Day & 14-Day OMR Flows"

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Appendix 4: Approach to Suspend Actions During High Flows

MEMO

Date: December 16, 2008

To: File

From: Paul Hutton

Subject: Modeling Delta Smelt High Flow Action Temporary Suspensions

This memo summarizes an approach that was developed to represent high flow periods when Delta smelt flow actions are temporarily suspended. The actions of interest include the following:

- Wanger Actions – The winter pulse flow action (on or after December 25) is temporarily suspended if the 3-day average flow at Freeport exceeds 80,000 cfs. Similarly, the pre-spawning adult flow action (January and February) is temporarily suspended if the 3-day average flow at Freeport exceeds 80,000 cfs.

- Delta Smelt Biological Opinion Actions – Action 2 is temporarily suspended if the 3-day average flows at Rio Vista and Vernalis exceed 90,000 cfs and 10,000 cfs, respectively.

Methodology

Given that (1) the actions are written in terms of 3-day flow averages and (2) typical water supply impact analyses are conducted assuming monthly average flows, a method is needed to characterize the action in terms of monthly average flows. Historical flows information from DAYFLOW was used to characterize relationships between 3-day flows and monthly flows. The desired product is to determine a frequency of exceeding the 3-day flow target as a function of a monthly flow value. This frequency will be used to proportionally reduce calculated water supply impacts in high flow months.

Results for Wanger Actions

Figure 4-1 plots the frequency that 3-day Freeport flows exceed 80,000 cfs as a function of monthly average Freeport flows (Q_F). The resulting mathematical frequency relationship (in percent units) is as follows:

0% when $Q_F < 50{,}000$ cfs

0.0126 * exp (0.000105*Q_F) when $50{,}000 \text{ cfs} \leq Q_F \leq 85{,}000$ cfs

100% when $Q_F > 85{,}000$ cfs

Results for BO Actions

Figure 4-2 plots the frequency that 3-day Rio Vista flows exceed 90,000 cfs as a function of monthly average Freeport flows (Q_F). The resulting mathematical frequency relationship (in percent units) is as follows:

0% when $Q_F < 50{,}000$ cfs

-146 + 0.00289*Q_F when $50{,}000 \text{ cfs} \leq Q_F \leq 85{,}000$ cfs

100% when $Q_F > 85{,}000$ cfs

Figure 4-3 plots the frequency that 3-day Vernalis flows exceed 10,000 cfs as a function of monthly average Vernalis flows (Q_V). The resulting mathematical frequency relationship (in percent units) is as follows:

0% when $Q_V < 6{,}000$ cfs

-49 + 0.00901*Q_V when $6{,}000 \text{ cfs} \leq Q_V \leq 16{,}000$ cfs

100% when $Q_V > 16{,}000$ cfs

The BO requires Rio Vista and Vernalis flows to simultaneously exceed the targets to temporarily suspend the flow action. For modeling purposes, it is assumed that these flows are statistically independent. Hence, the suspension frequency is calculated as the product of the individual frequencies. Since Rio Vista and Vernalis flows are modestly correlated, the proposed approach may somewhat understate the true suspension frequency. However, a cursory paired data evaluation suggested that the assumption will provide reasonable results.

Figure 4-1. Frequency of Wanger Freeport Flow Trigger as a Function of Monthly Freeport Flow

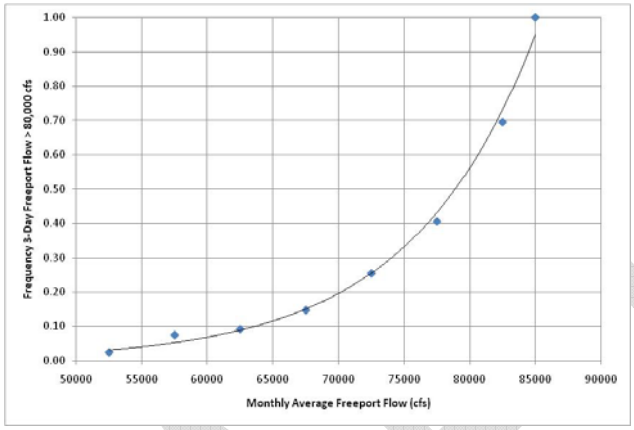


Figure 4-2. Frequency of BO Rio Vista Flow Trigger as a Function of Monthly Freeport Flow

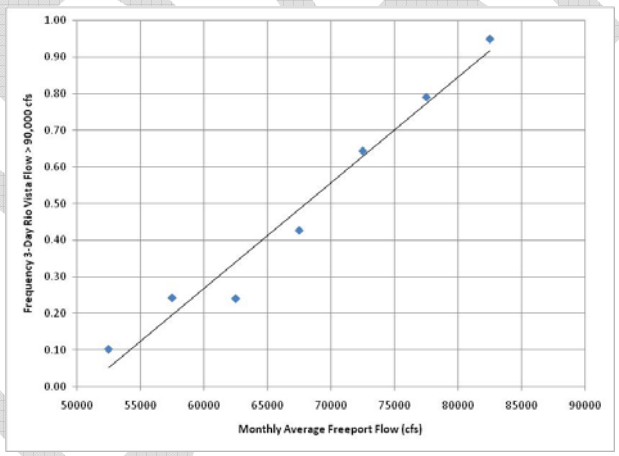
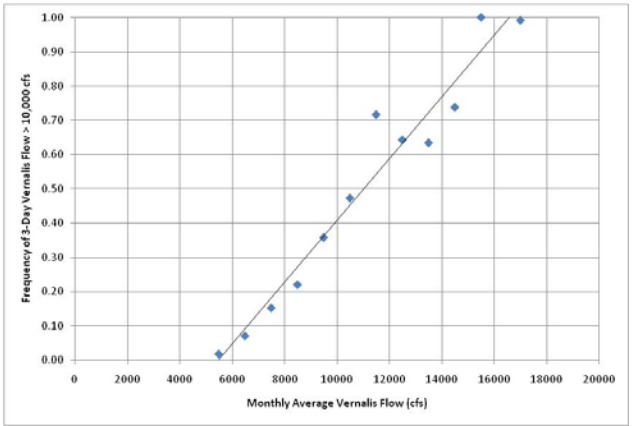


Figure 4-3. Frequency of BO Vernalis Flow Trigger as a Function of Monthly Vernalis Flow



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Appendix 5: Approach to Relate 5-Day & 14-Day OMR Flows

MEMO

Date: January 2, 2009

To: File

From: Paul Hutton

Subject: How Frequently Will 5-Day OMR Flows (Rather than 14-Day OMR Flows) Control Project Operations Under New Delta Smelt Biological Opinion?

Background

Several flow actions specified in the December 2008 Delta Smelt biological opinion place limits on reverse flows in Old and Middle Rivers. Limits are given as 14-day averages, but the simultaneous 5-day averages are to be within 25% of the 14-day averages. This memo summarizes an investigation to answer the question "How frequently will 5-day OMR flows, rather than 14-day OMR flows, control project operations under the new Delta smelt biological opinion?"

Water supply impact studies assume the 14-day average flow controls. Such an approach would not be conservative if 5-day flows frequently control project operations. Based upon a recent meeting with SWP and CVP operators, the CVP operators believe that fishery agencies will accept violations of the 5-day flow limit provided that project operators maintain relatively stable pumping operations. Is this belief that 5-day flows will not control operations valid? Will the courts or environmental groups accept such an operation? An investigation into the potential frequency of 5-day flow control seems prudent, given that we don't know the answers to such questions.

Methods

The following methods were employed:

- Review historical Delta flow and operations data for the period between January 1990 and May 2008.
- Identify periods when (1) pumping operations were relatively stable and (2) 5-day OMR flows were more negative than 14-day OMR flows. For periods prior to

October 2006, running average OMR flows were computed from raw 24-hour USGS data. For periods after October 2006, running average OMR flows were computed from tidally filtered USGS data.

- Evaluate differences between 5-day and 14-day OMR flows. Evaluate differences between (1) average period values and (2) peak period values. The rationale for evaluating both differences is as follows. While a 5-day flow violation may be acceptable as a "peak" event, the acceptability of a flow violation over longer periods seems less likely.

Results

Fifty periods were identified when pumping operations were relatively stable and 5-day OMR flows were more negative than 14-day OMR flows. The duration of these periods was typically 7 to 9 days. These periods are summarized in Table 5-1.

Differences Between Average Period Values. For each period, the average 5-day OMR flow is plotted against average 14-day OMR flow in Figure 5-1. This graph shows a linear relationship, suggesting that differences are relatively constant over a wide range of OMR flows. This relationship further suggests that the percent difference between 14-day flows and 5-day flows will generally be greater when the absolute flow value is small. At a 50% confidence interval, 5-day OMR flows are more negative than 14-day OMR flows by nearly 400 cfs (389 cfs). At one standard error, or about 67% confidence, 5-day OMR flows are more negative than 14-day OMR flows by more than 550 cfs (389 cfs + 174 cfs = 563 cfs). At two standard errors, or about 95% confidence, 5-day OMR flows are more negative than 14-day OMR flows by more than 700 cfs (389 cfs + 2*174 cfs = 737 cfs).

By solving the Figure 5-1 regression equation for a condition when the 5-day OMR flow is 25% more negative than the 14-day OMR flow, the following limits are identified when 5-day OMR flows will control:

14-day OMR flow = -1670 cfs at a 50% confidence interval

-2420 cfs at a 67% confidence interval

-3160 cfs at a 95% confidence interval

Differences Between Peak Period Values. For each period, the peak 5-day OMR flow is plotted against peak 14-day OMR flow in Figure 5-2. This graph also shows a linear relationship, suggesting that differences are relatively constant over a wide range of OMR flows. This relationship further suggests that the percent difference between 14-day flows and 5-day flows will generally be greater when the absolute flow value is small. At a 50% confidence interval, 5-day OMR flows are more negative than 14-day OMR flows by nearly 700 cfs (679 cfs). At one standard error, or about 67% confidence,

5-day OMR flows are more negative than 14-day OMR flows by nearly 1000 cfs (679 cfs + 297 cfs = 976 cfs). At two standard errors, or about 95% confidence, 5-day OMR flows are more negative than 14-day OMR flows by nearly 1300 cfs (679 cfs + 2*297 cfs = 1273 cfs).

By solving the Figure 5-1 regression equation for a condition when the 5-day OMR flow is 25% more negative than the 14-day OMR flow, the following limits are identified when 5-day OMR flows will control:

14-day OMR flow = -2980 cfs at a 50% confidence interval

-4280 cfs at a 67% confidence interval

-5580 cfs at a 95% confidence interval

Conclusions

This memo summarizes an investigation to answer the question "How frequently will 5-day OMR flows, rather than 14-day OMR flows, control project operations under the new Delta smelt biological opinion?" An analysis of historical flow and project operations data suggests that 5-day OMR flows will often control operations when the 14-day flow target is in the most stringent range of -1500 cfs to -2500 cfs. When the projects are operating to less stringent OMR flows in the range of -3000 cfs to -5000 cfs, 5-day OMR flows will occasionally be at least 25% more negative than 14-day OMR flows and might control project operations.

If the projects are required to strictly meet the 5-day OMR flow criteria, (1) the current water supply impact assumption of 14-day OMR flow control is not conservative and (2) it would be prudent to incorporate a factor of safety to address the 5-day flow criteria.

Paul Hutton 2/2/09

Figure 5-1. Average 5d OMR flows as a function of average 14d OMR flows during periods when pumping operations were stable and 5d flows were more negative than 14d flows.

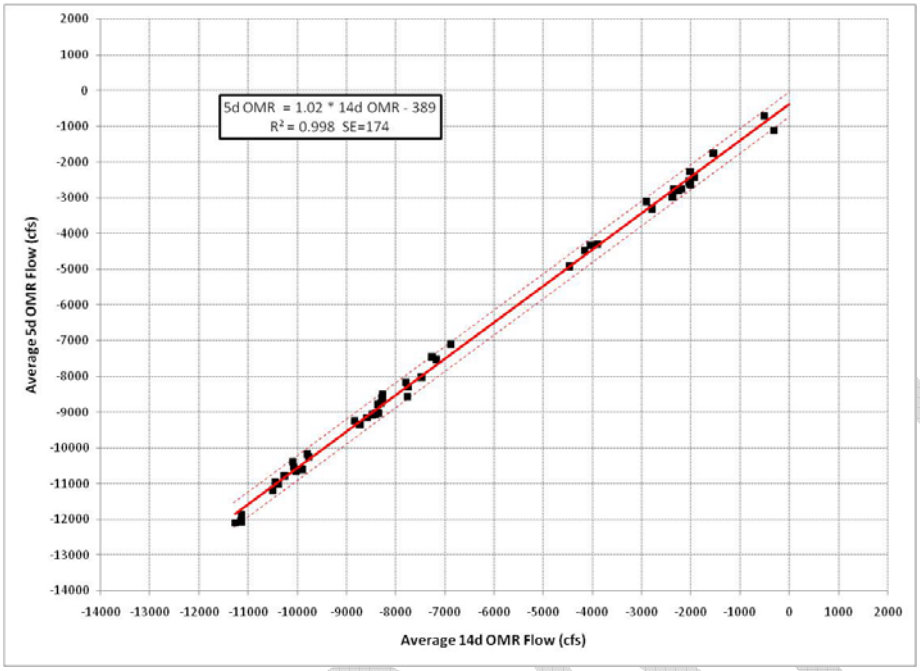
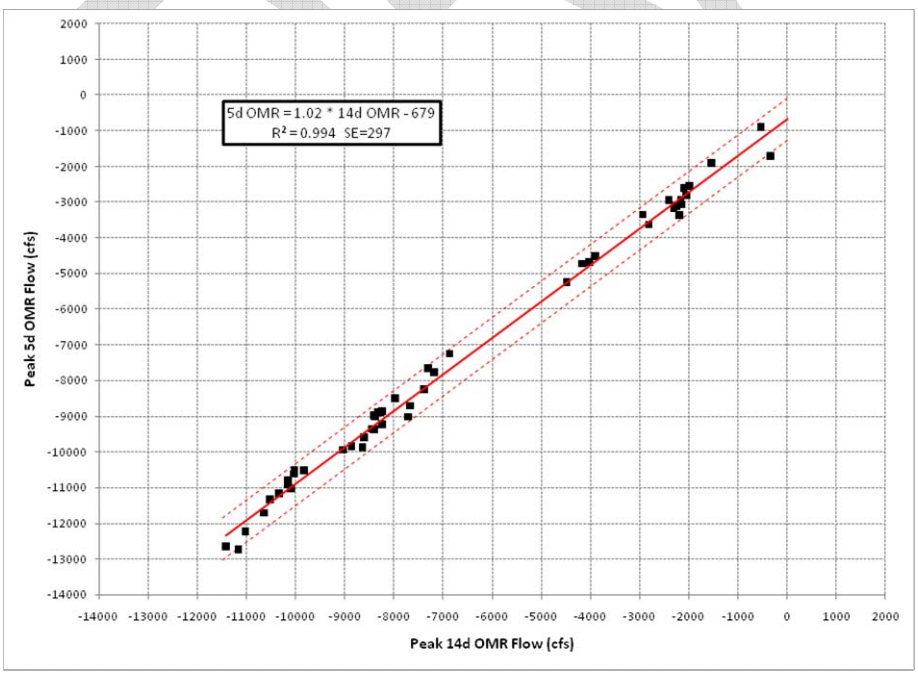


Figure 5-2. Peak 5d OMR flows as a function of peak 14d OMR flows during periods when pumping operations were stable and 5d flows were more negative than 14d flows.



Paul Hutton 2/2/09

Table 5-1. Fifty periods were identified when pumping operations were relatively stable and 5-day OMR flows were more negative than 14-day OMR flows.

Period			Daily Export Range (cfs)			14d Export Range (cfs)			Average OMR Difference (cfs)				Peak OMR Difference (cfs)				
Start Date	End Date	Duration (days)	Min	Max	Range	Min	Max	Range	14d	5d	Diff	%Diff	Date	14d	5d	Diff	%Diff
24-Jan-90	1-Feb-90	9	10000	10700	700	10400	10500	100	-8300	-8760	-460	6%	30-Jan-90	-8390	-9010	-620	7%
9-Feb-90	17-Feb-90	9	9900	10600	700	10400	10400	0	-8270	-8590	-320	4%	12-Feb-90	-8280	-8900	-620	7%
24-Feb-90	3-Mar-90	8	10000	10600	600	10400	10500	100	-8270	-8690	-420	5%	27-Feb-90	-8240	-8870	-630	8%
10-Mar-90	19-Mar-90	10	10000	10800	800	10300	10400	100	-8260	-8510	-250	3%	18-Mar-90	-8340	-8890	-550	7%
24-Mar-90	1-Apr-90	9	10300	10600	300	10300	10500	200	-8830	-9250	-420	5%	31-Mar-90	-9040	-9950	-910	10%
1-Apr-91	8-Apr-91	8	9300	10200	900	10200	10300	100	-7470	-8020	-550	7%	4-Apr-91	-7390	-8260	-870	12%
16-Mar-92	24-Mar-92	9	10000	10700	700	10300	10400	100	-8410	-9060	-650	8%	22-Mar-92	-8640	-9880	-1240	14%
20-Aug-93	27-Aug-93	8	10400	10900	500	10600	10700	100	-8730	-9350	-620	7%	24-Aug-93	-8870	-9850	-980	11%
4-Sep-93	10-Sep-93	7	10900	10900	0	10600	10700	100	-8360	-8790	-430	5%	9-Sep-93	-8420	-8990	-570	7%
18-Sep-93	23-Sep-93	6	10300	10900	600	10800	10900	100	-8370	-9030	-660	8%	20-Sep-93	-8450	-9360	-910	11%
1-Oct-93	9-Oct-93	9	10800	11100	300	10600	10900	300	-8340	-9040	-700	8%	3-Oct-93	-8240	-9240	-1000	12%
17-Oct-93	22-Oct-93	6	10800	10900	100	10900	10900	0	-7790	-8170	-380	5%	18-Oct-93	-7980	-8500	-520	7%
22-Nov-95	30-Nov-95	9	4300	4800	500	4400	4400	0	-2780	-3300	-520	19%	25-Nov-95	-2810	-3640	-830	30%
7-Dec-95	13-Dec-95	7	4200	4400	200	4300	4400	100	-2900	-3100	-200	7%	12-Dec-95	-2930	-3360	-430	15%
22-Dec-95	28-Dec-95	7	4200	4400	200	4200	4300	100	-2370	-2980	-610	26%	26-Dec-95	-2250	-3130	-880	39%
12-Aug-99	22-Aug-99	11	8700	11600	2900	10900	11300	400	-9800	-10180	-380	4%	20-Aug-99	-10040	-10630	-590	6%
28-Aug-99	5-Sep-99	9	10900	11600	700	11100	11400	300	-10260	-10790	-530	5%	1-Sep-99	-10350	-11180	-830	8%
13-Sep-99	19-Sep-99	7	11400	11500	100	11500	11500	0	-10090	-10390	-300	3%	17-Sep-99	-10030	-10530	-500	5%
3-May-00	9-May-00	7	1700	2200	500	2100	2300	200	-1930	-2410	-480	25%	8-May-00	-1980	-2560	-580	29%
5-May-01	13-May-01	9	1500	1700	200	1500	1500	0	-2000	-2630	-630	32%	11-May-01	-2190	-3380	-1190	54%
22-May-01	29-May-01	8	800	1600	800	1500	1500	0	-2020	-2590	-570	28%	27-May-01	-2140	-3080	-940	44%
22-Jul-01	29-Jul-01	8	7900	8800	900	8100	8300	200	-8580	-9160	-580	7%	25-Jul-01	-8610	-9610	-1000	12%
20-Aug-01	26-Aug-01	7	7700	8900	1200	8100	8400	300	-8470	-9080	-610	7%	23-Aug-01	-8410	-9370	-960	11%
6-Sep-01	12-Sep-01	7	7200	8300	1100	7500	7600	100	-7760	-8580	-820	11%	8-Sep-01	-7720	-9030	-1310	17%
19-Sep-01	25-Sep-01	7	7200	8200	1000	7700	7800	100	-7750	-8310	-560	7%	22-Sep-01	-7680	-8720	-1040	14%
27-Apr-02	3-May-02	7	1400	1500	100	1500	2000	500	-2190	-2750	-560	26%	30-Apr-02	-2160	-2960	-800	37%
12-May-02	18-May-02	7	1500	1500	0	1500	1500	0	-2030	-2540	-510	25%	16-May-02	-2040	-2810	-770	38%
26-May-02	31-May-02	6	1600	1600	0	1600	1600	0	-2010	-2260	-250	12%	31-May-02	-2100	-2620	-520	25%
1-May-03	7-May-03	7	1400	1500	100	1500	1500	0	-2340	-2760	-420	18%	3-May-03	-2400	-2950	-550	23%
15-May-03	22-May-03	8	1500	2300	800	1400	1700	300	-2250	-2800	-550	24%	20-May-03	-2300	-3190	-890	39%
15-Aug-03	22-Aug-03	8	11300	11600	300	11200	11400	200	-11260	-12100	-840	7%	20-Aug-03	-11430	-12670	-1240	11%
31-Aug-03	6-Sep-03	7	11200	11500	300	11400	11500	100	-11140	-12070	-930	8%	3-Sep-03	-11170	-12750	-1580	14%
13-Sep-03	21-Sep-03	9	10000	11600	1600	11200	11400	200	-11130	-11880	-750	7%	16-Sep-03	-11030	-12240	-1210	11%
25-Jul-05	31-Jul-05	7	11500	11600	100	11500	11500	0	-10020	-10670	-650	6%	28-Jul-05	-10110	-11040	-930	9%
7-Aug-05	15-Aug-05	9	10900	11700	800	11500	11600	100	-10390	-11020	-630	6%	13-Aug-05	-10530	-11350	-820	8%
22-Aug-05	28-Aug-05	7	11600	11700	100	11500	11600	100	-10500	-11190	-690	7%	25-Aug-05	-10650	-11720	-1070	10%
13-Aug-06	18-Aug-06	6	11500	11600	100	11500	11600	100	-10070	-10560	-490	5%	15-Aug-06	-10170	-10930	-760	7%
26-Aug-06	3-Sep-06	9	11300	11600	300	11500	11500	0	-9760	-10260	-500	5%	1-Sep-06	-9840	-10520	-680	7%
10-Sep-06	16-Sep-06	7	11000	11600	600	11500	11600	100	-9900	-10610	-710	7%	14-Sep-06	-10090	-11040	-950	9%
5-Nov-06	13-Nov-06	9	8600	10000	1400	9200	9400	200	-6880	-7100	-220	3%	7-Nov-06	-6870	-7260	-390	6%
15-Nov-06	23-Nov-06	9	9200	10000	800	9200	9500	300	-7260	-7460	-200	3%	20-Nov-06	-7310	-7660	-350	5%
2-Dec-06	6-Dec-06	5	8400	10200	1800	9600	9800	200	-7170	-7530	-360	5%	4-Dec-06	-7180	-7780	-600	8%
27-Jan-07	1-Feb-07	6	6300	6900	600	6500	6800	300	-3890	-4300	-410	11%	28-Jan-07	-3900	-4530	-630	16%
7-Feb-07	13-Feb-07	7	6400	6900	500	6800	6800	0	-4160	-4490	-330	8%	10-Feb-07	-4170	-4730	-560	13%
22-Feb-07	28-Feb-07	7	6600	6900	300	6800	6900	100	-4030	-4330	-300	7%	25-Feb-07	-4020	-4700	-680	17%
3-Apr-07	9-Apr-07	7	5600	7100	1500	6200	6600	400	-4460	-4920	-460	10%	7-Apr-07	-4480	-5250	-770	17%
15-May-07	20-May-07	6	1200	1500	300	1400	1500	100	-1540	-1750	-210	14%	18-May-07	-1540	-1920	-380	25%
14-Aug-07	24-Aug-07	11	11600	11600	0	11500	11600	100	-10450	-10960	-510	5%	17-Aug-07	-10160	-10810	-650	6%
3-May-08	9-May-08	7	1500	1500	0	1500	1600	100	-310	-1110	-800	258%	6-May-08	-330	-1720	-1390	421%
18-May-08	22-May-08	5	1400	1700	300	1500	1500	0	-500	-710	-210	42%	20-May-08	-530	-900	-370	70%

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